

A Critical Review of the Solar Array Manufacturing Industry Costing Standards

Jet Propulsion Laboratory
Pasadena, California

Theodore Barry & Associates Management Consultants

TB&A

(NASA-CR-153401)	A REVIEW OF THE SOLAR	N77-30608
ARRAY MANUFACTURING INDUSTRY COSTING		
STANDARDS (Barry (Theodore) and Associates)		
HC A07/MF A01	CSCI 10A	Unclas
	G3/44	41993

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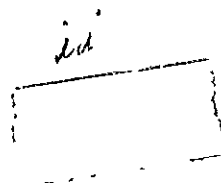
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ACKNOWLEDGEMENTS

We extend our sincere appreciation for the courtesy and cooperation we received from the many individuals who participated in this study for the Low-Cost Silicon Solar Array project at the Jet Propulsion Laboratory.

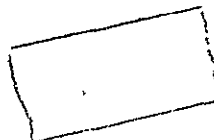
Mr. Robert Chamberlain deserves special recognition for his effort to develop the Solar Array Manufacturing Industry Costing Standards.

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SAMICS CRITIQUE
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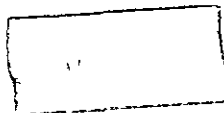
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EXECUTIVE
SUMMARY

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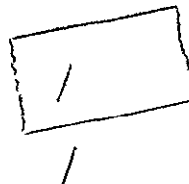
SAMICS SUPPORT STUDY

The Jet Propulsion Laboratory (JPL) is currently examining the feasibility of a new industry to produce photovoltaic solar energy collectors similar to those used on spacecraft. To do this, a standardized costing procedure is being developed. Theodore Barry & Associates has been contracted to provide industrial management consulting and facilities design engineering support for the implementation of the Solar Array Manufacturing Industry Costing Standards (SAMICS).

The support study will supply the following information:

- 1) SAMICS CRITIQUE
- 2) STANDARD DATA BASE
 - a) Cost Account Structure
 - b) Expense Item Costs
 - c) Inflation Rates
 - d) Indirect Requirements Relationships
 - e) Standard Financial Parameter Values
- 3) FACILITIES CAPITAL COST ESTIMATING RELATIONSHIPS
- 4) MANUFACTURING PRICE ESTIMATES
- 5) CONSTRUCTION LEAD TIMES
- 6) PRODUCTION START-UP TIMES
- 7) SUPPORT STUDY DOCUMENTATION

This report documents the findings, analyses, and recommendations of the SAMICS critique. These and other support study results will be incorporated in the SAMIS III computer program scheduled for release at the end of September 1977.



CRITIQUE PURPOSE AND SCOPE

The SAMICS model is designed to compare the cost of producing solar arrays using alternative manufacturing processes. The constructive criticism of the SAMICS methodology is intended to enhance its implementation as a practical design tool. To accomplish this, the critique focuses on three main elements of the SAMICS procedure:

- 1) WORKBOOK FORMAT AND PRESENTATION
- 2) THEORETICAL MODEL VALIDITY
- 3) STANDARD FINANCIAL PARAMETERS

- Each element is analyzed with respect to the JPL project goals.
- Important opportunities for improving the SAMICS procedures are identified.
- Specific recommendations are made to convert these opportunities into tangible benefits.
- Adoption of the recommendations will strengthen the SAMICS methodology, providing a smoother transition from a theoretical realm to a practical application procedure.

As described in this report, the SAMICS model is an ingenious mathematical formulation, as a result of a truly ambitious effort on the part of its developers. The most important opportunities for improvement lie in converting it to a practical application procedure. Thus, the emphasis of the critique has been to simplify this transformation.

The main body of the report consists of three sections corresponding to the workbook format and presentation, the theoretical model validity, and the standard financial parameters. These are followed by a set of appendices containing more detailed discussions. This summary section highlights findings, analyses, and recommendations.

WORKBOOK FORMAT AND PRESENTATION

● OBJECTIVES

The SAMICS workbook presents a manual computation procedure to estimate the cost of manufacturing solar arrays. The procedure is also being formulated as a computer simulation program (SAMIS III).

The Solar Array Manufacturing Industry Costing Standards consist of:

1. A standard format for expressing input data describing the manufacturing processes.
2. A set of standardized financial data to unify economic and accounting assumptions.
3. A collection of algorithms for combining the process descriptions with the standard financial data to produce an estimate of the prices and process-by-process cost components.

● APPLICATIONS

Alternative manufacturing processes are currently being synthesized by approximately 50 JPL subcontractors. Previous cost estimates by these subcontractors have not been comparable because of differences in accounting standards, economic assumptions, and financial parameters. In the future, these and other subcontractors will be required to use the uniform standards to provide comparable cost estimates.

The cost estimates provided by the subcontractors will be compared to determine the best sequence of manufacturing processes to produce solar arrays as a function of the annual quantity produced. Hopefully these results will indicate the feasibility of the JPL project goal to reduce today's solar array prices of \$25/watt to less than \$.50/watt for annual production quantities of 500 Megawatts by 1986.

JPL scientists will also use the simulation model to assess the impact of economies of scale, industry structure, industrial management techniques, and government policy actions. The model is expected to provide the business community with financial data to analyze the attractiveness of the proposed industry. Government policy makers will be able to evaluate alternative actions such as changes in tax rates, investment tax credits, industry subsidies, and low-cost loans.

● ANALYSIS

JPL analysts are currently performing the first test application of the manual calculation procedure. During the course of this exercise, several opportunities for improving the workbook format and presentation have been identified.

The SAMICS model is an excellent mathematical formulation; however, the workbook presentation is too theoretical for a practical application procedure.

In its present form, the workbook is understandable only to those with highly technical and quantitative training. The subcontractors, who will be the primary users, have diverse educational backgrounds and working experience. This dictates that the workbook procedure be presented in a more comprehensible manner.

The procedure for preparing the input data sheets is not adequately explained. The importance of this explanation cannot be overemphasized since accurate and complete input data is essential for meaningful results.

The calculations are complex and time-consuming, especially the matrix inversion, and mistakes are inevitable. Given the correct input data, a computer could perform the calculations more cost effectively and reliably.

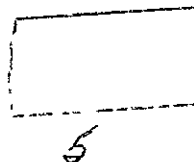
The single output report shows a process-by-process breakdown of the direct, indirect, and administrative expenses. This large amount of information would be more readable on a series of output reports. The current format will be unfamiliar and difficult to interpret for business people and financial analysts.

Given the current workbook, the average user will certainly become confused and discouraged with the complexity of the model. On the other hand, he would be quite impressed if it were simple for him to apply and it provided him useful, understandable results. Since a computer program will be available, this does not require a detailed knowledge of the model calculations. Rather, it requires a detailed explanation and guidelines for preparing the input data sheets accurately, a simplified overview of the calculations as they relate to the output, and a clear description of the types of output reports that are available. The scope of the output reports should be broad enough to fulfill the needs of the intended audience.

• RECOMMENDATIONS

To transform the SAMICS workbook into a more practical application procedure, the following actions should be taken:

1. The workbook should be converted to an orientation manual for users of the computer program illustrating the procedure and the format of the input data required. The practical users should not be expected to, and probably would not be able to, perform the step-by-step calculations manually since the procedure is simply too complex and errors are inevitable.



2. The description and illustration of the input data entry procedure and format should be expanded to alleviate the difficulties and errors associated with the input data preparation.
3. The manual calculation procedure should be replaced by an overview of the computer computations to eliminate the confusion and mystification caused by the complex theoretical exposition.
4. The single output report should be simplified and augmented with projected financial statements (a balance sheet and an income statement), financial ratios, and energy consumption factors to make the SAMICS methodology and output more useful and understandable to the general business community and government policy analysts.

More detailed recommendations for the format and content of the workbook are presented in the main body of this report.

With the implementation of these changes in the workbook, JPL can look forward to greater cooperation from the subcontractors by providing a more valuable research tool to evaluate manufacturing processes.

THEORETICAL MODEL VALIDITY

● MODEL OVERVIEW

The developers of the theoretical model have formulated a general structure for the design and analysis of industrial systems. The model will generate a long-run or steady state supply curve for each alternative manufacturing process. The supply curve indicates the price as a function of the quantity produced that the industry would have to receive to recover all costs including a return on investment.

The model consists of four components summarized below:

- i) Manufacturing Process Model
- ii) Factory Construction and Staffing Algorithm
- iii) Capital Requirements Model
- iv) Financial Model of the Firm

The industry structure is defined as either a single firm or a series of firms where each firm contains one or more manufacturing processes to produce a single product. The manufacturing processes and the demand for the industry's end product are specified exogenously.

The manufacturing process model translates these exogenous descriptions into direct capacity requirements, indicating the steady state or long-run scale of operation.

The factory construction and staffing algorithm generates the indirect facilities and staff requirements to complement the direct manufacturing process requirements.

The capital requirements model estimates the values of land, facilities, equipment, and working capital from each firm's direct and indirect needs.

Finally, the financial model of the firm approximates annual operating and overhead expenses (including profit) for a steady state manufacturing year. A set of standard financial parameters are applied to compute the eventual market price required to provide a reasonable return on equity investment.

● INDUSTRY GROWTH

At present, the model is restricted to the supply side of the market. It does not forecast the potential demand or product mix. The solar arrays may range in size from household units to commercial power generating plant size. However, the size of the solar arrays is not explicitly modeled nor is the demand forecasted, rather an average order size is assumed and demand is varied from 10^5 to 10^{10} peak-watts per year.

The model is also static in the sense that it does not treat industry growth. Given the assumed level of demand, a hypothetical plant is designed and constructed to produce at an output rate which exactly satisfies the demand. However, demand is seldom static and the long-term growth pattern is especially important for a new product.

Since the capacity decision involves a major capital investment, the optimal initial size and scale of facilities and a strategic plan for capacity expansion are important financial considerations. The dominant variable influencing these decisions is the expected demand for the firm's product translated into capacity requirements over time.

● SHORT-RUN COST VARIATION

Long-run cost functions are a valuable management tool for strategically planning the optimal scale of operations as well as for the selection among competing manufacturing processes. However, the short-run cost variations are

also an important consideration indicating how costs change when the plant is not operated at its design capacity. Although the model is not currently programmed to analyze short-run cost variations, it does contain provisions for approximating them.

● INDUSTRY STRUCTURE

In the SAMICS long-run cost analysis, the manner in which facility size varies with output volumes is of primary interest. However, the extent of horizontal and vertical integration will also influence the number and size of the individual plants. These factors have significant consequences for the long-run cost variations, but they have not been clearly defined. The model is capable of assessing the impact of vertical integration easily and, with a slight extension, horizontal integration could also be examined.

This is important because increasing the extent of horizontal integration in certain areas could lead to decreasing returns to scale after a point. The warehousing and distribution functions have not been modeled for the proposed solar array manufacturing industry. Due to increasing transportation costs, these are the factors which would lead to diseconomies of scale. If these elements of production are not incorporated, the model will result in increasing or at least constant returns to scale over all levels of capacity.

● GOVERNMENT ACTIONS

The impact of a variety of government actions can be evaluated with the SAMICS model. The potential actions include changes in the tax rates, investment tax credits, subsidies for capital investment, low interest guaranteed loans, and inflation rates. Depending on the assumptions made, each of these actions could alter the eventual price of solar arrays. Thus, government policy alternatives are an important feature of the SAMICS model. This capability



could be improved and expanded in two specific areas:

- i) The Investment Tax Credit Model could be modified to reflect the changes introduced by the Tax Reform Act of 1976.
- ii) The model could be augmented with the Job Tax Credit proposed in the 1977 Tax Reduction and Simplification Bill.

● MODEL EQUATIONS

In general, the model equations are logically consistent and theoretically valid subject to the constraints of the intended scope. The level of detail is an appropriate balance between that required for realistic results and that required for cost effective results. However, several opportunities for improving the equations do exist within the current scope of the model. Because of the complexity, explanations and recommendations regarding these opportunities are deferred to the main body of the report.

● RECOMMENDATIONS

Recommendations for strengthening the validity of the theoretical model in a broader perspective are summarized below.

At some point in the future, the model should be expanded to analyze the dynamic interaction of supply and demand. Such a dynamic model would provide the capability of examining the implications of industry growth and alternative capacity expansion policies on the eventual cost of solar arrays and the attractiveness of the investment. Furthermore, the impact of demand incentives such as tax credits for installing solar units could be assessed.

To improve the control of costs and the investment risk, due to uncertainty in the manufacturing process capacity, the model should be capable of analyzing the short-run cost variation associated with each facility size. This could be accomplished by varying the manufacturing process usage fractions and the number of operating shifts per day. With this capability, decisions regarding the optimal manufacturing process and scale of operation could be made more prudently. However, at this stage, it would be more practical to concentrate on the long-run cost variation treating process capacities deterministically.

The industry structure should be more precisely defined with respect to the extent of horizontal and vertical integration for the long-run costs being estimated. For a given level of output, these costs could vary substantially depending on the assumptions regarding horizontal and vertical integration. Ultimately, both of these factors should be examined in greater depth.

The government policy actions should be extended to include the proposed Job Tax Credit and the revised Investment Tax Credit. These extensions would strengthen the model by reflecting the Tax Reform Act of 1976 and the proposed Tax Reduction and Simplification Act of 1977.

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STANDARD FINANCIAL PARAMETERS

The Solar Array Manufacturing Industry Costing Standards (SAMICS) financial parameters for an economic basis for the evaluation and comparison of alternative manufacturing processes. For the purpose of this critique, the parameters have been divided into ten functional categories:

1. Investment Tax Credit Parameters
2. Depreciation Parameters
3. Corporate Tax Rates
4. Discount Time Factors
5. Price Level Adjustment Parameters
6. Capital Discount Rate Parameters
7. Miscellaneous Cost Factors
8. Production Turnover Time Lags
9. Land Value Parameters
10. Energy Consumption Factors

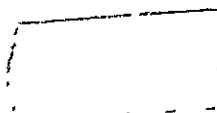
The values assigned to these parameters have consequences for the solar array price estimates. Thus, each value has been carefully scrutinized. Several revisions are recommended to ensure conformance with IRS tax laws and Generally Accepted Accounting Principles. Implementation of these revisions will strengthen the SAMICS price estimates.

The subsequent sections detail the findings, analyses, and recommendations of the critique with respect to the workbook format and presentation, the theoretical model validity and the standard financial parameters.

WORKBOOK

FORMAT AND PRESENTATION

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FINDINGS

This section describes the Solar Array Manufacturing Industry Costing Standards (SAMICS) workbook format and presentation with respect to its objectives, applications, limitations, and testing. This descriptive information formed the basis of the analysis and recommendations presented in the following sections.

OBJECTIVES

The developers of the SAMICS model have provided a general structure for the design and analysis of complex industrial systems. The SAMICS workbook is a manual version of this analytical model which is also being formulated as a computer simulation program (SAMIS).

The SAMICS workbook presents a step-by-step procedure for applying the Solar Array Manufacturing Industry Costing Standards. These standards consist of:

1. A standard format for expressing input data describing the manufacturing processes.
2. A set of standardized financial data to unify economic and accounting assumptions.
3. A collection of algorithms for combining the process descriptions with the standard financial data to produce an estimate of the prices and process-by-process cost components of all products manufactured within the modeled industry.

Exhibit I outlines the contents and general format of the workbook.

The purpose of the SAMICS model is to provide a standardized procedure for estimating the cost of producing solar arrays using alternative manufacturing

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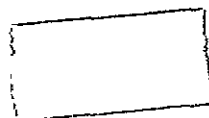
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processes. SAMICS was developed to facilitate the comparison of these competing manufacturing processes which are being synthesized and tested by approximately 50 subcontractors. Previous cost studies by these subcontractors have not been comparable because of differences in accounting standards, economic assumptions, and financial parameters. In the future, these and other subcontractors will be required to use this methodology to provide comparable cost estimates and other financial data for the potential industry. Thus, the subcontractors constitute the primary group of users of the SAMICS methodology. They will probably use the computer program rather than the workbook to perform the actual calculations which are quite time-consuming. However, the workbook will be the main document for user orientation and will provide the format to specify input to the computer simulation.

APPLICATIONS

The cost estimates provided by the subcontractors will be evaluated to determine the best sequence of manufacturing processes to produce solar arrays as a function of the annual quantity produced. These estimates will indicate the feasibility of the overall project goal to reduce today's solar array prices of \$20,000 to \$25,000 per Kilowatt to less than \$500 per Kilowatt at annual industry production quantities of 500 Megawatts.

The workbook is designed to compute all costs incurred to construct facilities and to operate a plant producing solar arrays. These costs, aggregated over the system lifetime and converted to an annual basis, are divided by the annual power producing capability of the manufactured arrays. The result is an estimate of the price which would exactly recover the costs of production including a return on investment to the stockholders and creditors.



The audience for the results includes the general business community, financial analysts, economists, potential investors, and government policy makers, as well as engineers and scientists.

The model is expected to provide the business community and potential investors with financial data to analyze the attractiveness of the proposed investment. Government policymakers will be able to assess the impact of alternative actions such as changes in tax rates, investment tax credits, industry subsidies, and interest on guaranteed or low-cost loans.

JPL scientists will use the simulation model first to compare competitive manufacturing processes and secondly to assess the impact of economies of scale, industry structure, and industrial management. The model could be used to generate a long-run or steady state supply curve for each alternative manufacturing process. As shown in Exhibit II, this curve indicates the price as a function of the quantity produced that the industry would have to receive to recover all costs, including a return on investment.

LIMITATIONS

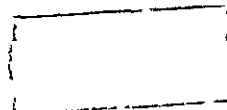
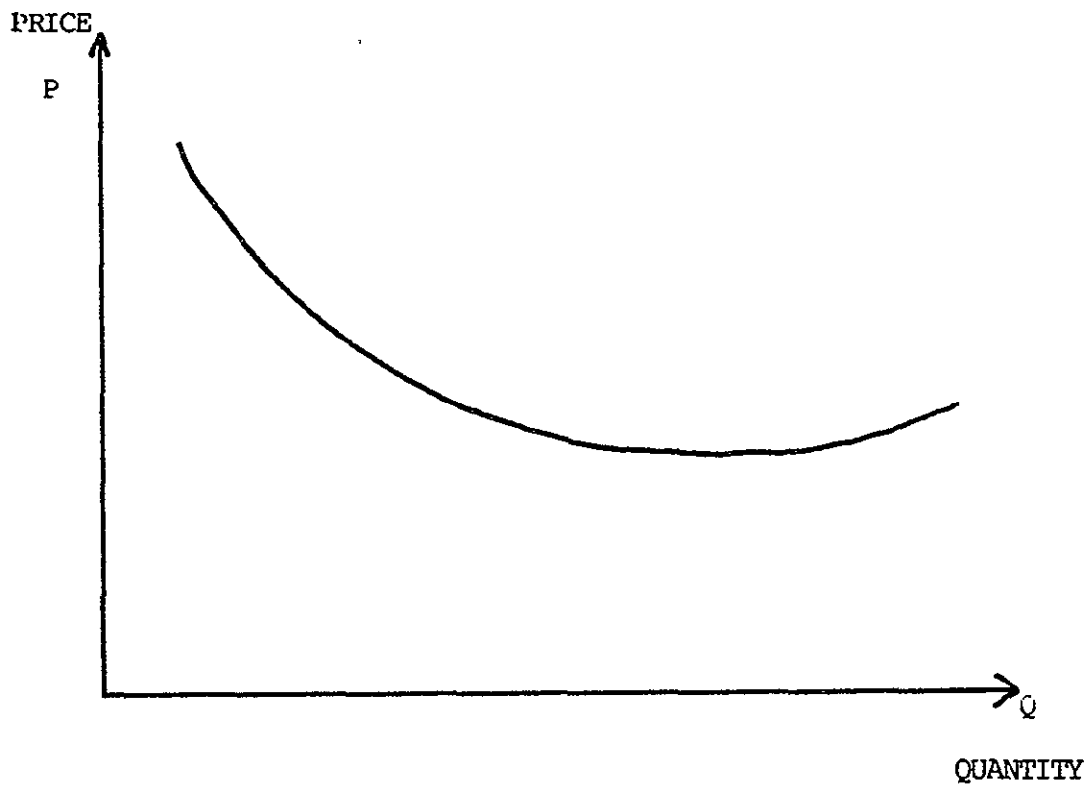
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The model is also static in the sense that it does not treat industry growth. Given the assumed level of demand, a hypothetical plant is designed and constructed to produce at an output rate which exactly satisfies the demand. This is referred to as a steady state or equilibrium solution.

EXHIBIT II

SOLAR ARRAY MANUFACTURING INDUSTRY

SUPPLY CURVE



At some point in the future, the model may be expanded or an additional model may be developed to analyze the dynamic interaction of supply and demand. Such a dynamic model would provide the capability of examining the implications of industry growth and alternative capacity expansion policies on the eventual cost of solar arrays and the attractiveness of the investment. Furthermore, the impact of demand incentives such as tax credits for installing solar units could be assessed.

TESTING

The SAMICS workbook is in the process of being tested. The SAMIS computer program is in the design stage and is scheduled to be released in October 1977. The JPL subcontractors are using interim costing standards until the workbook and computer program are completed.

JPL analysts are currently performing the first test application of the workbook procedure manually. Exhibit III displays the workbook input data format. These data sheets were prepared for a complete sequence of manufacturing processes based on information from one of the subcontractors. During the course of this exercise, several opportunities for improving the workbook format and presentation have been identified. These opportunities are outlined below.

- The process description input data sheets were not completely filled out. For example, one of the machine names was omitted.
- The input data sheets required skilled and experienced judgment to estimate some parameters such as process usage fractions and useful machines lives. Process usage fractions of 95% were specified for some manual operations.

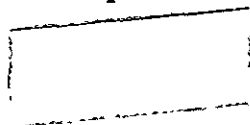


EXHIBIT III

SAMICS WORKBOOK
INPUT DATA FORMAT

ORIGINAL PAGE IS
OF POOR QUALITY

Part I

PART I: INPUT DATA

STEP 1: GIVE THE INDUSTRY DESCRIPTION A NAME

To facilitate future references to this particular industry description, give it an acronym STD , and a name

STEP 2: DESCRIBE THE INDUSTRY PRODUCT

The objective is New Photovoltaic Power Capability, which is expressed in peak-watts/year

(Acronym)

(Name)

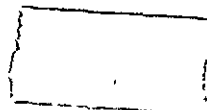
The final product of the industry is PSM, Packaged Solar Modules

Production is measured in modules/year.

The performance of the product, with respect to the objective is given by the relationship

Hardware performance, $H =$ _____ peak-watts/module.

A brief description of the design of the industry product follows.



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Part II

SAMICS WORKBOOK
INPUT DATA FORMAT

FORMAT A: DESCRIPTION OF A PROCESS

Process Acronym: _____	Process Name: _____
Output Product Acronym: _____	Output Product Name: _____
	Output Product Units: _____

PROCESS CHARACTERISTICS (of a machine consisting of the pieces of equipment described below):

- | | | |
|---|-------------|--|
| ① Output rate, | $r =$ _____ | Units of
Output product / Minute of
Operation |
| ② Processing time, | $t =$ _____ | Minutes of
Operation / Cycle |
| ③ Process usage fraction (Assume 2 Shifts), | $f =$ _____ | Minutes
of
Operation / Factory
Open
Minute |

EQUIPMENT COST FACTORS (including any special safety and pollution control):
(use a column for each piece of equipment with a different life.)

- | | |
|------------------------------------|------------------------------|
| Name of this piece of equipment | _____ |
| ④ Price year | t_p _____ year |
| ⑤ Cost of this piece of equipment | C _____ year t_p dollars |
| ⑥ Anticipated useful life | L _____ years |
| ⑦ Salvage value after L years | S _____ year t_p dollars |
| ⑧ Cost of removal and installation | R _____ year t_p dollars |
| ⑨ Time reqd. to remove and install | u _____ shifts lost |

Payment float interval

(when paid — when installed) v 0 0 0 years

Inflation rate g 6 6 6 %/year

Tax life L_{tax} roundup ($\rho * L$) Years

Tax depreciation method double declining balance

Accounting (book) life L_{book} roundup (L)

Book depreciation method straight line

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SAMICS WORKBOOK
INPUT DATA FORMAT

Part III

FORMAT A: PROCESS DESCRIPTION (continued)

Process Acronym: _____

DIRECT FACILITIES AND PERSONNEL REQUIREMENTS (list directly required items from Accounts A and B of the Cost Account Structure, add additional sheets if necessary.):

Item	Amount/Machine	Item	Amount/Machine
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

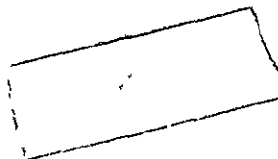
DIRECT UTILITIES, BYPRODUCTS, AND COMMODITIES REQUIREMENTS (list items from Accounts C, D, E. Add additional sheets if necessary.)

Item	Amount/Cycle	Item	Amount/Cycle	Item	Amount/Cycle
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

REQUIRED INTRA-FIRM AND INTRA-INDUSTRY PRODUCTS (every product listed here must appear as the output product of some process description):

Product Acronym	Name of Product	Yield = Amount of Output per unit of this Product
_____	_____	_____
_____	_____	_____
_____	_____	_____

- Indirectly required cost items were incorrectly specified on the input sheets as direct needs. Since the SAMICS procedure will internally generate standardized estimates of all the indirect requirements, only directly required items are to be entered on the input sheets.
- Ambiguous descriptions, such as miscellaneous item, were substituted for cost account item numbers corresponding to some directly required process inputs. Required inputs were also assigned to the wrong cost account categories.
- The input quantity units specified were not always consistent with the cost account structure units. Similarly the yield factor units were not always consistent with input and output product units resulting in invalid conversions.
- Some of the standard financial parameters, which are held constant and not to be specified by the SAMICS user, are listed on every input data sheet.
- The number of shifts/day and the amount of factory open time per year are not input parameters which the user can alter. The assumptions are 8 hours/shift, 2 shifts/day, and 52 weeks/year.
- No by-products or pollutants were considered and the definitions of these items are unclear.



- The units of measure for some of the utilities in Cost Account C are inadequate to calculate the corresponding facilities capacity requirements.
- The computation procedure has resulted in some unreasonable indirect requirements such as a disproportionately large warehouse.
- The inventor of the mathematical model had to be called many times by the analyst for clarification of the calculation procedure.
- The calculations are extremely tedious and time-consuming. Several weeks have been expended on the simplified test example.



ANALYSIS

In this section, the opportunities for improving the SAMICS workbook format and presentation are carefully examined with respect to its future practical application by the JPL subcontractors and the utility of its results for the intended audience. The difficulties experienced in preparing the input data sheets are scrutinized since this is the most critical aspect of the entire procedure. Finally, an assessment is made of what is needed to convert the theoretical model to a practical application procedure.

The SAMICS model is an ingenious mathematical formulation as a result of a tremendous and ambitious effort by the developers. However, the workbook presentation is a confusing mixture of theory and practical application.

The subcontractors, who will be the primary users of the procedure, have diverse educational backgrounds and working experience. This dictates that the workbook procedure be presented in a manner which is easily understood by nearly anyone. In its current form, the workbook is understandable only to those with highly technical and quantitative training. The intended users will probably not be familiar or comfortable with matrix algebra and the language of mathematical symbols and will also find it difficult to think in general or parametric terms.

The computation procedure is complex while the narrative explanation is brief and ambiguous. The user is required to make judgments where misinterpretation will result in errors and inconsistent results.

The calculations are time-consuming, particularly the matrix inversion, and mistakes are inevitable. A computer program could perform the calculations more cost effectively and reliably.

The procedure for preparing the input data sheets is not adequately explained. The importance of this explanation cannot be overemphasized since accurate and complete input data is required to produce meaningful results. The current input data sheets could be simplified by removing excess information and unnecessary mathematical symbol notation.

The distinction between direct and indirect requirements is a clever theoretical formulation, however, it is a difficult concept for the uninitiated layman to comprehend. A clear, concise discussion of this concept is essential for the correct preparation of the input data and interpretation of the results.

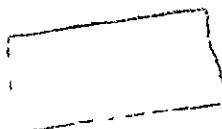
Given the current workbook, the average practical user will certainly become confused and discouraged with the complexity of the model. On the other hand, he would be quite impressed if it were simple for him to apply and it provided him useful, understandable results. Since a computer program will be available, this does not require a detailed knowledge of the model calculations. Rather, it requires a detailed explanation and guidelines for preparing the input data sheets accurately, a simplified overview of the calculations as they relate to the output, and a clear description of the types of output reports that are available. The scope of the output reports should be broad enough to fulfill the needs of the intended audience.

Thus, the purpose of the workbook should be to provide the users with a grasp of the model structure and assumptions emphasizing the type and format of the

input data required and the output reports that can be generated. Then, a computer can be employed to do most of the work.

The current SAMICS output report provides a process-by-process breakdown of the direct, indirect, administrative, capital, and miscellaneous expenses incurred. The amount of data is too voluminous for a single summary report. The format will also be unfamiliar and difficult to interpret for business people and financial analysts.

The model output should also address a potential government policy question concerning energy consumption. The fundamental issue is whether the energy pay-back time of the solar cells will be less than the operational lifetime of an array. In this context, the energy pay-back time can be defined as the length of time a solar cell must operate to generate an amount of energy equal to that expended in its production. As part of the output, this information will be of interest to government energy consumption analysts. In addition, a process-by-process breakdown of the energy consumed to produce the solar arrays would indicate potential areas for energy reduction research.



RECOMMENDATIONS

The following paragraphs contain recommendations for improving the SAMICS workbook format and presentation based on the preceding factual information and analysis. A recommended table of contents for the revised workbook is shown in Exhibit IV. The suggested content of each section is discussed below.

The most substantial changes recommended are:

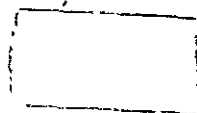
1. The workbook should be converted to an orientation manual for users of the computer program illustrating the procedure and the format of the input data required. The practical users should not be expected to, and probably would not be able to, perform the step-by-step calculations manually since the procedure is simply too complex and errors are inevitable.
2. The description and illustration of the input data entry procedure and format should be expanded to alleviate the difficulties and errors associated with the input data preparation.
3. The manual calculation procedure should be replaced by an overview of the computer computations to eliminate the confusion and mystification caused by the complex theoretical exposition.
4. The single output report should be simplified and augmented with projected financial statements (a balance sheet and an income statement), financial ratios, and energy consumption factors to make the SAMICS methodology and output more useful and understandable to the general business community and government policy analysts.

EXHIBIT IV
RECOMMENDED SAMICS USER'S MANUAL
TABLE OF CONTENTS

I	INTRODUCTION
II	INPUT DATA ENTRY PROCEDURE AND FORMAT
III	OVERVIEW OF THE COMPUTATION PROCEDURE
IV	OUTPUT REPORT DESCRIPTIONS

APPENDICES

A	COST ACCOUNT CATALOG
B	INDIRECT REQUIREMENTS RELATIONSHIPS
C	INITIAL FACILITIES COST RELATIONSHIPS
D	STANDARD FINANCIAL PARAMETERS
E	SAMPLE INPUT DATA SHEETS
F	SAMPLE OUTPUT REPORTS



INTRODUCTION

A flowchart of the procedure would be extremely helpful in conceptualizing the model. A statement of the objectives and scope and a discussion of the most critical assumptions and limitations of the model in simple terms should also be included. A clear, concise description of the type of input data required and the difference between direct and indirect requirements would be very beneficial. This should be followed by an overview of the computation procedure and a general description of the output reports generated. Finally, a guide to the organization of the manual and a reference to the model equations for interested readers would complete the introduction.

INPUT DATA ENTRY PROCEDURE AND FORMAT

This is the most important and critical section of the workbook for the user to understand. To mitigate the data preparation task, two types of simplified input data sheets should be provided:

1. Manufacturing Process Sequence Input Summary Sheet
2. Process Description Input Data Sheet

The recommended formats for these sheets are displayed in Exhibits V and VI. These sheets have been purged of unnecessary information and mathematical symbols. The amount of factory open time per year has been included as an input option on the first input data sheet. The standard financial parameters have been removed from the second input data sheet since they are not input parameters.

These input data sheets should be accompanied by, and referred to in, a narrative tutorial on the input data entry procedure. This tutorial should accomplish the following objectives:

EXHIBIT V

MANUFACTURING PROCESS SEQUENCE INPUT
SUMMARY SHEET

I. INDUSTRY DESCRIPTION

Industry Acronym _____ Industry Name _____

Industry Objective: _____

Product Acronym _____ Product Name _____

Annual Production Units _____

Hardware Performance _____ peak watts/module

Product Design Description: _____

Factory Open Time/Year _____ hours/year

II. PROCESS SEQUENCE SUMMARY

<u>Step</u>	<u>Process Name</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

EXHIBIT VI

PROCESS DESCRIPTION INPUT DATA SHEET Part I

Process Acronym: _____

Process Name: _____

Product Acronym: _____

Product Name: _____

Product Units: _____

PROCESS CHARACTERISTICS

Output Rate: _____ units/minute

Processing Cycle Time: _____ minutes/cycle

Process Usage Time: _____ process time/factory open time
(fraction of available time) (operating minutes/shift)

EQUIPMENT COST FACTORS*

	Type 1	Type 2	Type 3
Equipment Name(s):	_____	_____	_____
Base Price Year (for Equipment Costs):	_____	_____	_____
Equipment Cost (\$/machine):	_____	_____	_____
Anticipated Useful Life (years):	_____	_____	_____
Salvage Value (\$/machine):	_____	_____	_____
Cost of Removal & Installation (\$/machine):	_____	_____	_____
Removal & Installation Time (hours/machine):	_____	_____	_____

*Use one column for each type of equipment with a different useful life.



EXHIBIT VI

PROCESS DESCRIPTION INPUT DATA SHEET Part II

Process Acronym _____ Process Name _____

DIRECT FACILITIES AND PERSONNEL REQUIREMENTS

Catalog Number	Requirement Description	Units (Amount/Cycle)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

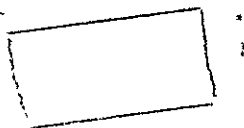
DIRECT UTILITIES, BY-PRODUCTS, POLLUTANTS, AND COMMODITIES REQUIREMENTS

Catalog Number	Requirement Description	Units (Amount/Cycle)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

DIRECTLY REQUIRED INTRA-INDUSTRY PRODUCTS

Product Acronym	Product Name	Yield Factor (Usable Output/Input)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

- Emphasize the importance of preparing these input data sheets accurately and completely.
- Carefully define each cost account category and give specific examples to illustrate the differences between categories, particularly by-products and pollutants.
- Provide a clear, concise description of the difference between direct and indirect requirements and stress the fact that only direct requirements should be specified as input.
- Provide contingency instructions on how to proceed if an input item does not appear in the cost account requirements catalog. This catalog should be updated as new requirements are identified and transmitted to all users in a timely fashion.
- Explain what an item is and stress that the input item units (amount/cycle) must be consistent with the units listed in the requirements catalog and the yield factor units must be consistent for a valid conversion from input to output. An input data validity check should be incorporated in the computer program to provide diagnostic error messages for inconsistent or invalid input data.
- Offer sound guidelines and rules of thumb for estimating each of the input items which may require judgment.
- Refer to a completed set of input data sheets for an example sequence of processes in Appendix E.



OVERVIEW OF THE COMPUTATION PROCEDURE

Part II of the workbook, the calculations section, should be replaced with an overview of the computation procedure. This section should describe the nature of the calculations performed, the critical economic assumptions made, and the financial parameters used. The purpose should be to provide a sufficient explanation of the calculations in elementary terms so that the results may be interpreted in the proper perspective.

OUTPUT REPORTS

- A summary of the output reports generated and a brief explanation of each as a guide to interpretation of the results. A reference to completed output reports contained in Appendix F.
- A simplified version of the current Format L output summary sheet. This sheet should be separated into several different output reports, possibly one cost breakdown for each manufacturing process and one overall summary.
- To make the SAMICS methodology and output more useful and understandable to the general business community, a projected income statement for the steady-state firm during the manufacturing year should be generated. This document summarizes the costs of operating a business and compares the enterprise's costs with revenues or income in a manner familiar to all managers and accountants. The generation of this document will require classifying all SAMICS costs according to generally accepted accounting principles. This cost accounting system will insure that the SAMICS procedures conform with tax, financial, and



legal requirements. The income statement normally indicates the gross profit, net operating profit, and net profit after taxes resulting from operations during a given period of time. An explanation of this statement for a typical manufacturing firm is presented in Appendix A of this report.

The SAMICS model currently accounts for most of the operating costs required to generate this document. However, in some cases, they are classified and combined according to a scheme which will not be easily understood by management. It should not be too difficult to incorporate this standardized accounting system and to augment the model output with a projected income statement for the design manufacturing year. This capability will greatly enhance the usefulness of the model by expanding the potential audience for its output.

- To promote the ease of understanding the SAMICS output for financial people and government policy analysts, a projected financial balance sheet should also be produced as part of the output. A projected balance sheet for the model industry would summarize the assets and liabilities as of a given date (the design manufacturing year) in accordance with generally accepted accounting principles. Since this statement is a familiar means of communication in the business world, it would facilitate analysis by potential investors and policy makers. It would also supply standardized data to compute the various financial ratios commonly used to evaluate and



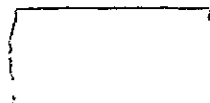
compare alternative investments. A sample balance sheet for SAMCO, the hypothetical enterprise, is illustrated in Appendix B of this report.

- Financial analysts have developed several standard measures to evaluate investment opportunities. The appropriate measures vary with the type of application. In the case of SAMICS, financial analysts would be interested in the capital structure of the firm, projections of future profitability, and the cash flow ability of the firm to service debt over the long run.

To accomplish this, several standard financial ratios could be computed from the projected SAMICS financial statements: the balance sheet and the income statement. An explanation of the types of financial ratios and equations for computing them are presented in Appendix C of this report.

The analysis of these financial ratios involves making comparisons for alternative manufacturing processes and for similar industries. The interpretation of these financial ratios will give a skilled and experienced financial analyst a better understanding of the potential financial condition and performance of the solar energy firm than he would obtain from the analysis of the financial statements alone.

- The SAMICS output should include a separate energy consumption report. The contents should summarize a process-by-process breakdown of the energy consumed to manufacture the solar arrays and an estimate of the energy pay-back time. This information would be



valuable to government energy policy analysts providing another measure to evaluate the relative merit of the alternative manufacturing processes.



THEORETICAL
MODEL VALIDITY



FINDINGS

This section presents a brief, albeit comprehensive, description of the Solar Array Manufacturing Industry Costing Standards (SAMICS) theoretical model. These informative facts are analyzed and improvements are recommended in the following two sections.

MODEL OVERVIEW

The purpose of the SAMICS model is to provide a standardized procedure for estimating the cost of producing solar arrays with alternative manufacturing process sequences. The model will be applied to assess the commercial viability of new solararrayprocess technologies. However, given the proper input data, the model structure is flexible enough to support the design and analysis of any manufacturing industry.

Exhibit I presents a graphic overview of the model procedure for estimating the long run or steady state manufacturing cost. This procedure can be divided into four submodels which are summarized below.

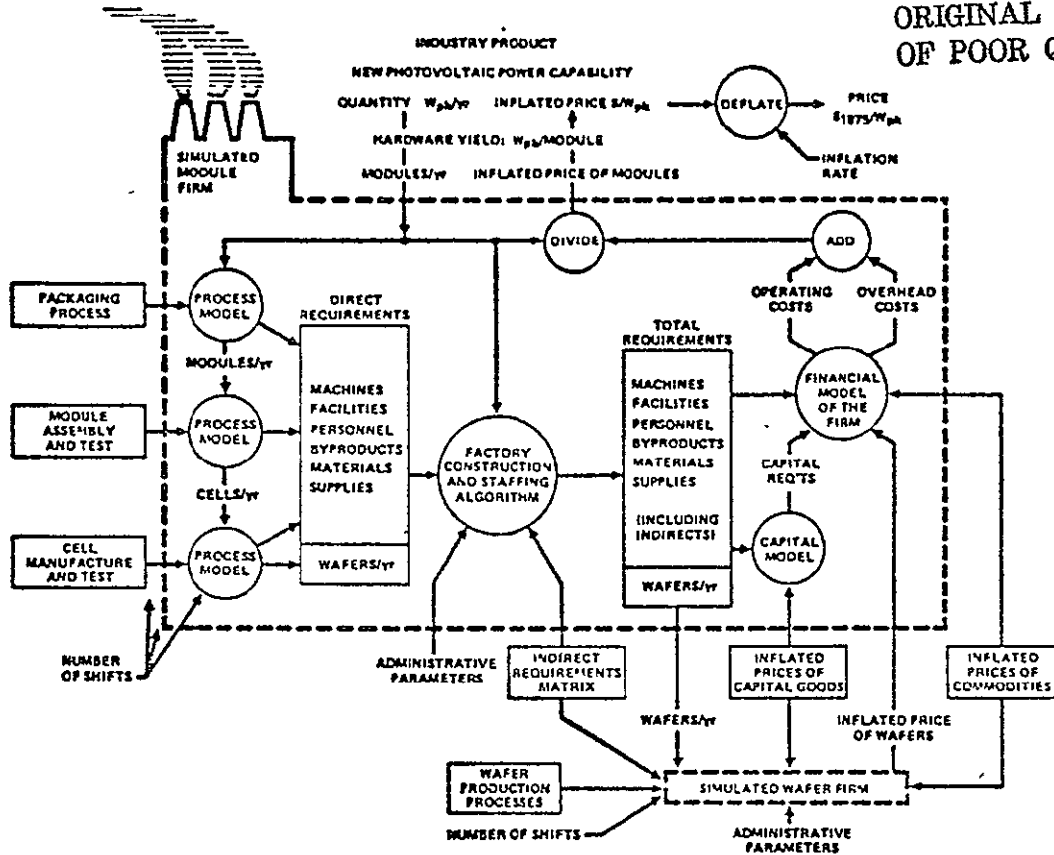
- i) Manufacturing Process Model
- ii) Factory Construction and Staffing Algorithm
- iii) Capital Requirements Model
- iv) Financial Model of the Firm

The industry structure is defined as either a single firm or a series of firms where each firm contains one or more manufacturing processes to produce a single product. The manufacturing processes and the demand for the industry's end product are specified exogenously.

The manufacturing process model translates these exogenous descriptions into direct capacity requirements, indicating the steady state scale of operation.

OVERVIEW OF THE SAMICS THEORETICAL

MODEL PROCEDURE

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The factory construction and staffing algorithm generates the indirect facilities and staff requirements to complement the direct manufacturing process requirements.

The capital requirements model estimates the values of land, facilities, equipment, and working capital from each firm's direct and indirect needs.

Finally, the financial model of the firm approximates annual operating and overhead expenses (including profit) for the steady state manufacturing year. A set of standard financial parameters are applied to compute the eventual market price required to provide a reasonable return on equity investment.

The following paragraphs contain more detailed descriptions of each of the four submodels.

Manufacturing Process Model

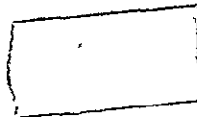
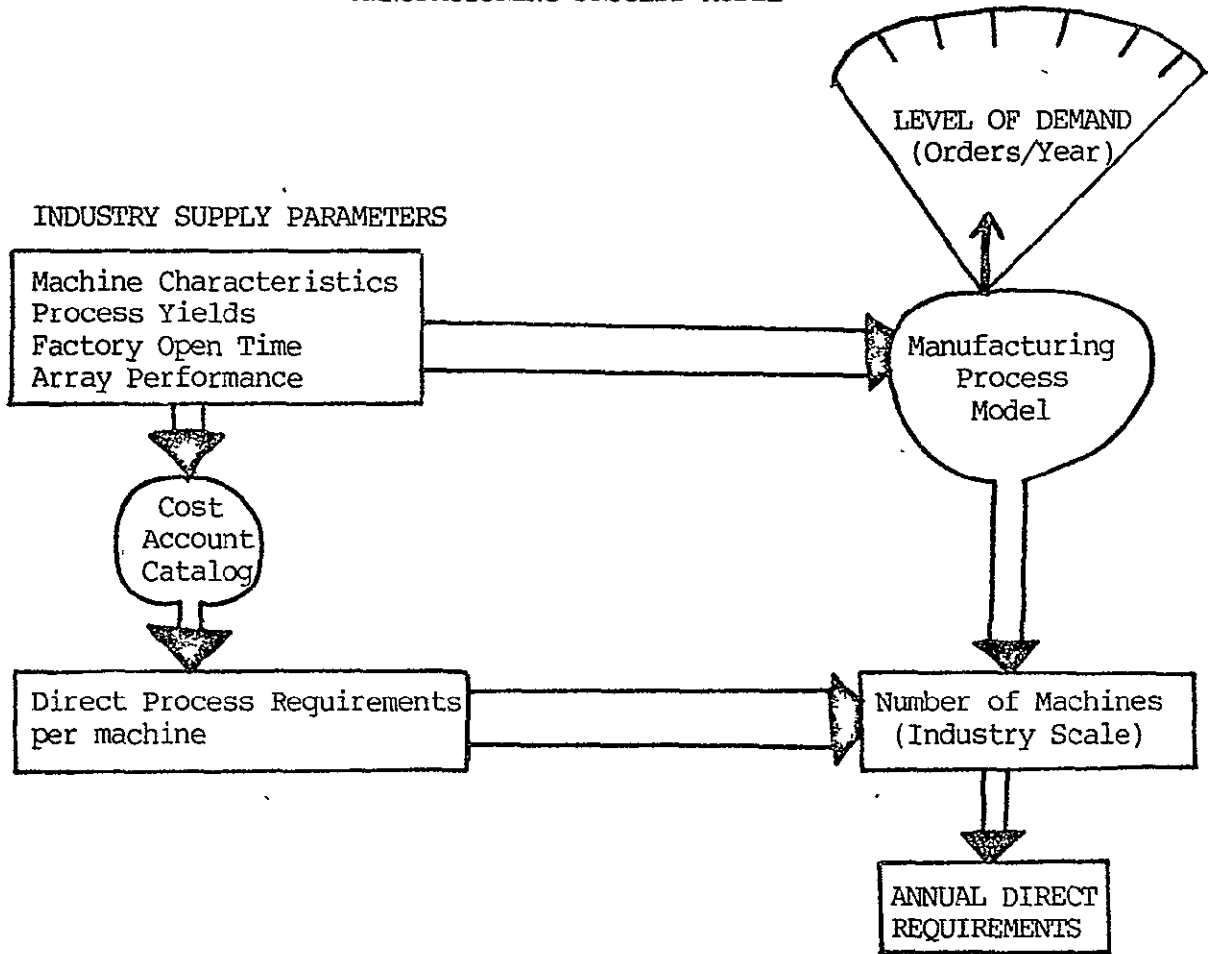
The manufacturing process submodel translates the SAMICS input data into direct capacity requirements. An overview of this procedure is displayed in Exhibit II. The manufacturing processes are described exogenously by specifying the machine characteristics, the direct process requirements, the process yields, and the array performance factor.

- Machine characteristics include the type of equipment; purchase, installation, and removal costs; useful life and salvage value; output rate; cycle length; process usage fraction (processing time/factory open time); and the number of shifts required for removal and installation.
- Direct process requirements consist of facilities, personnel, materials, utilities, by-products, and intra-firm intermediate products that are required to operate each type of machine.



EXHIBIT II

MANUFACTURING PROCESS MODEL



- Process yields express the amount of useable output per unit of each intermediate input product.
- The array performance factor is the peak power producing capacity of the solar modules (peak-watts/module).

These inputs are supplied for a complete sequence of manufacturing processes typically designed to convert purified silicon into packaged solar arrays. All direct process requirements are selected from a standard cost account catalog. This catalog contains descriptions for any item that may be required directly or indirectly by any of the promising alternative manufacturing sequences. Where appropriate, it also provides prices versus quantities, price years, and inflation rates.

The assumed level of demand is applied to the descriptive information about the manufacturing processes to determine the number of each type of machine required by the industry. This is tantamount to establishing the design capacity for the steady state scale of operation. The economies of scale are assessed by varying the level of demand.

Finally, the direct requirements per machine cycle (all facilities, personnel, utilities, commodities, and by-products) are multiplied by the number of machine cycles to obtain the annual amounts of all direct manufacturing requirements. These industry requirements include intra-firm "orders" for intermediate products needed to satisfy the demand for the end product.

The manufacturing process model equations are a fairly straight-forward application of the input data descriptions. These "machine" descriptions and the solar array performance rating (peak-watts/module) are the only non-standardized input to the SAMICS costing procedures.

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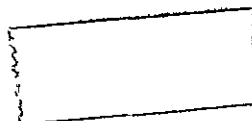
Factory Construction and Staffing Algorithm

Factory operations require more staff, more facilities, and more supplies than those directly required to operate the machines generated by the manufacturing process model. These items are generally needed to operate any manufacturing plant. The quantities of some are dependent upon the machine's direct requirements, while others are independent of the specific manufacturing processes.

Examples of the former are supervisors, managers, land area, maintenance shops, guards, janitors, electricity, heating, and air conditioning. These are referred to as indirect requirements whose amounts can be determined as a function of certain direct requirements. There are also needs that are independent of the production process, such as a company President and salespersons.

The model assumes that every firm has one President, regardless of the size of the firm. It is further assumed that each salesperson can produce Z orders per year regardless of the product size. The average order size is specified as a table lookup function of the annual demand for the firm's product. Thus, given the demand Q and the average order size, A , the number of salespersons, S , is calculated as: $S = Q/(A * Z)$.

The firm's direct needs are augmented with these two requirements: a President and salesperson. All other administrative needs are inferred from the direct and indirect factory operating manufacturing process requirements. To accomplish this, an indirect requirements matrix, R , is defined, whose elements, r_{ij} , describe how much of the i th requirement is needed per unit of the j th requirement.



For example, if the first requirement is factory floor space and the fifth requirement is janitors, then r_{51} is the ratio of the number of janitors required per unit of factory floor space. This ratio is specified as a table lookup function of the amount of factory floor space.

The generation of this matrix requires a list of all of the direct and indirect requirements of the factory and estimates of the significant relationships between their quantities. This matrix differs from the input-output matrix commonly used in economics in that many of its elements are functional relationships rather than constant values. The reason being that the quantities of most indirect requirement vary non-linearly with the scale of operation.

Given the direct requirements vector, D , from the manufacturing process model (augmented with salespersons and a President) and the indirect requirements matrix, R , the total requirements of the firm, T , are calculated using the following equation: $T = (I - R)^{-1} D$, where I is an identity matrix of the same size as the R matrix.

The total indirect needs are then obtained by subtracting the direct needs from the total needs.

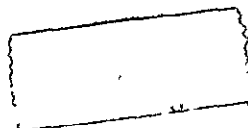
$$\begin{aligned} \text{INDIRECT NEEDS} &= T - D \\ &= \begin{bmatrix} (I-R)^{-1} & -I \end{bmatrix} D \end{aligned}$$

This completes the factory construction and staffing algorithm.

Capital Requirements Model

The firm's capital requirements are determined from the direct and indirect needs. Because of different financial treatments, the model distinguishes between four categories of capital requirements:

- i) Land
- ii) Facilities
- iii) Equipment
- iv) Working Capital



The SAMICS methodology for assessing the values of each category is discussed below.

- i) Land. The land on which the manufacturing facility is situated is assumed to appreciate in value at its inflation rate, g_{land} .

The initial purchase price is the product of the amount of land required, T_{land} , and the cost per unit, C_{land} , at time, t_p .

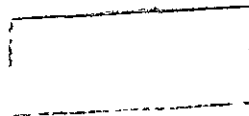
$$\begin{array}{l} \text{Initial} \\ \text{Purchase} \\ \text{Price} \end{array} = C_{\text{land}} * T_{\text{land}}$$

This is treated as an initial one-time cost. The value of the land, for both tax and accounting purposes, is assumed to be the inflated purchase cost which is equivalent to the estimated market value during the design manufacturing year, t_m .

$$\begin{array}{l} \text{Land} \\ \text{Value} \\ \text{at time, } t_m \end{array} = C_{\text{land}} * T_{\text{land}} * (1 + g_{\text{land}})^{t_m - t_p}$$

- ii) Facilities. The value of facilities depends on the direct and indirect manufacturing facilities requirements. The magnitudes of most of these costs are nonlinear functions of the industry scale. Thus, the most substantial economies of scale are expected from the facilities costs.

The SAMICS model assumes for simplicity that the initial facility cost can be approximated as the sum of functions of the individual facilities items. That is, the total facilities cost is computed as the sum of the separate facilities component costs.



- iii) Equipment. The value of equipment is computed directly from the input cost data and the numbers of machines from the manufacturing process model. The steady state annual equipment investments, INV, are approximated by the average equipment replacement expense assuming uniform replacement over time. This cost includes the purchase, installation, and removal costs minus the estimated salvage value.

All equipment costs are inflated to steady state manufacturing year dollars using the following equations for each type of machine:

$$INV = \frac{M}{L} * (C - S) * (1 + g)^{tm - tp} * (1 + K)^{-V}$$

Where:

M = Number of Machines

L = Useful Life

C = Purchase Installation and Removal Cost per machine
in price year dollars

S = Salvage Value per machine in price year dollars

g = Equipment Inflation Rate

K = Internal Rate of Return

V = Payment Float Interval (years)

tm = Steady State Manufacturing Year

tp = Equipment Price Year

- iv) Working Capital. Money is required to finance the company for operating expenses incurred prior to the receipt of payments for the products. SAMICS estimates the amount of working

capital required by multiplying the average annual operating expense, OPR, by the average turnover time lag, LAG, expressed as a fraction of a year:

$$WCAP = OPR * LAG$$

- The time lag between the payment of operating expenses and the corresponding receipt of product revenues is estimated as follows:

$$LAG = IN.LAG + X.LAG * PROC.TIME + OUT.LAG + PAY.LAG$$

$$IN.LAG = \text{Raw Materials Inventory Time}$$

$$X.LAG = \text{Processing Time Multiplier}$$

$$PROC.TIME = \text{Goods-In-Process Inventory Time}$$

$$OUT.LAG = \text{Finished Goods Inventory Time}$$

$$PAY.LAG = \text{Accounts Receivable Collection Time}$$

The firm's annual operating expenses, denoted OPR, are calculated as the sum of the labor, utilities, and commodities factory costs. Facilities, equipment, and by-product costs are excluded from this calculation.

SAMICS assumes that each manufacturing process produces only one main product. Consequently, anything else produced by a process, whether it generates revenue or incurs a cost for its disposal (a pollutant), is treated as a by-product.

Financial Model of the Firm

The SAMICS model treats many of the expenses that accountants typically refer to as factory overhead as indirect operating costs. These indirect costs, such as indirect labor, factory supplies, utility services, and equipment maintenance, are computed by the factory construction and staffing algorithm. However, there are several additional administrative expenses and periodic



overhead costs which have not yet been accounted for. The periodic costs include taxes, interest, depreciation, and net income or profit to the owners. The fiscal relationships governing these expenses are contained in the financial model of the firm.

- Required Revenue Condition

The normal procedure in venture analysis is to forecast the market demand for the firm's product at a given price and then to estimate the resulting profit. In SAMICS, this procedure is reversed: the return on equity is specified; a level of demand is assumed; the total cost of producing this level is calculated; and finally, the market price is estimated by applying the rate of return to the total cost. This price estimate includes the required profit but does not reflect the interaction of market forces.

$$\text{REVENUE} = \text{COST}$$

The underlying assumption for reversing the roles of profit and price is the requirement that total annual revenues equal total annual cost including a reasonable return on investment.

- Annual Revenues

Total annual revenues are set equal to the sum of the firm's main product sales plus by-product sales. These by-products include pollutants with negative "prices" associated with their disposal.

$$\text{REVENUE} = \text{PRODUCT.SALES} + \text{BY-PRODUCT.SALES}$$

Total annual costs are set equal to the sum of the costs of each item in the total requirements vector and the remaining overhead expenses.

$$\text{COST} = \text{OPERATING.EXPENSE} + \text{OVERHEAD}$$



The remaining expense items are corporate income taxes, other taxes, interest on corporate debt, insurance, miscellaneous expenses, return on equity, amortization of one-time costs, and replacement of capital. The model treatment of these expenses is outlined below for each item:

$$\begin{aligned}\text{OVERHEAD} = & \text{INCOME.TAX} + \text{OTHER.TAX} + \text{INTEREST} \\ & + \text{INSURANCE} + \text{RETURN.ON.EQUITY} \\ & + \text{MISC.EXPENSE} + \text{CAPITAL.REPLACEMENT} \\ & + \text{AMORTIZED.ONE.TIME.COST}\end{aligned}$$

• Corporate Income Tax

The firm's tax liability is computed by subtracting deductible expenses from the annual revenue and multiplying by the combined federal and state tax rate. This tax liability is then reduced by the investment tax credit. Deductible expenses include the annual operating expenses, other non-income taxes, depreciation, insurance, interest, and miscellaneous expenses.

$$\text{TAX.LIABILITY} = (\text{REVENUE} - \text{DEDUCTIONS}) * \text{TAX.RATE}$$

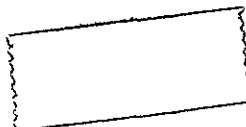
$$\begin{aligned}\text{DEDUCTIONS} = & \text{OPERATING.EXPENSES} + \text{OTHER.TAX} \\ & + \text{DEPRECIATION} + \text{INSURANCE} \\ & + \text{INTEREST} + \text{MISC.EXPENSE}\end{aligned}$$

$$\text{INCOME.TAX} = \text{TAX.LIABILITY} - \text{INVEST.TAX.CREDIT}$$

• Investment Tax Credit

An investment tax credit is computed separately for each type of equipment and facility based on the useful tax lives. These tax lives are set equal to a constant fraction, ρ , of the estimated physical life, L .

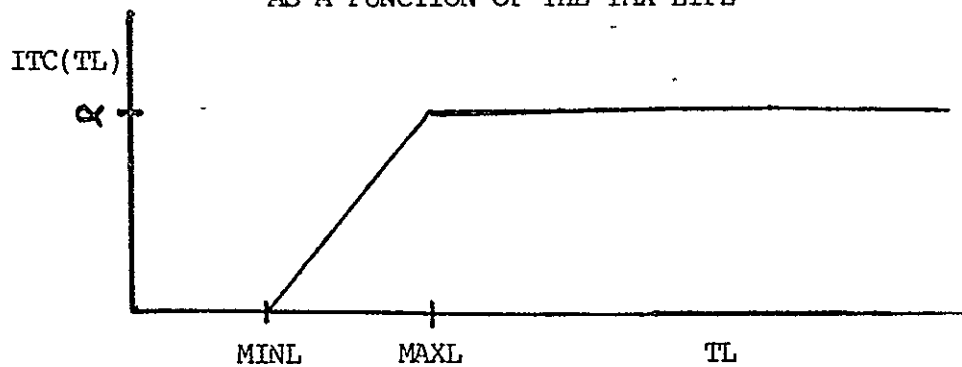
$$TL = \rho * L$$



The allowable investment tax credit rate for a given piece of equipment or facility component is modeled as a function of the tax life and the maximum credit rate, α , allowed by the IRS. This function is expressed symbolically and graphically as follows:

$$ITC(TL) = \begin{cases} \alpha & \text{for } TL \geq MAXL \\ \left(\frac{TL - MINL}{MAXL - MINL} \right) \alpha & \text{for } MINL < TL < MAXL \\ 0 & \text{for } TL \leq MINL \end{cases}$$

INVESTMENT TAX CREDIT RATE
AS A FUNCTION OF THE TAX LIFE

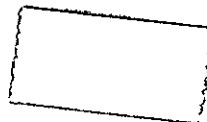


The allowable tax credit rate is computed for each qualified investment and applied to the annual replacement cost. The total investment tax credit for the firm is the sum ranging over all kinds of equipment and facilities.

$$INVEST.TAX.CREDIT = \sum_j REPLACE.COST_j * ITC(TL_j)$$

• Capital Replacement

Capital replacement costs for facilities and equipment are approximated by assuming uniform wear or obsolescence so that a constant fraction of the equipment and facilities must be replaced each year. For facilities, this fraction is the



inverse of the life time, L . However, since the equipment is not used during its installation, additional capital is required.

These capital replacement costs are expressed as follows:

$$\text{REPLACE.COST}_j = \begin{cases} \text{FAC.COST}_j / L_j & \text{for facilities} \\ \frac{M_j}{L_j} * \left(C_j - S_j \right) * X & \text{for equipment} \end{cases}$$

Where X is a multiplier to allow for machine installation and removal time.

• Depreciation

The SAMICS model treats depreciation for tax purposes separately from the accounting book value depreciation. First, the tax lives of assets are assumed to be less than the expected useful or book lives. Second, the replacement costs of assets are inflated over time while the book values are not. Third, different depreciation schedules, such as straight line or double declining balance, may be selected for income tax deductions and book valuation.

For tax purposes, the depreciation is computed as a function of the annual replacement cost, tax life, depreciation method, and inflation rate. For capital valuation of the firm, the total book value of all assets is computed.

• One-time Costs

The SAMICS treatment of one-time costs incurred during the construction and start-up production periods will be revised later in the support study. These one-time cost cash flows will be identified and



amortized over the life of the facility. A capital recovery factor based on the firm's internal rate of return will be applied to amortize these costs which include working capital, land purchase, construction, and start-up production costs.

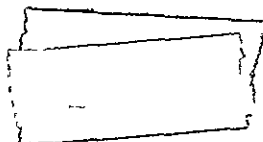
- Valuation of the Firm

The total capital value of the firm is used to approximate debt interest, return on equity, non-income taxes, and insurance premiums. This capital value is computed as the sum of the inflated land value, working capital, and the total book value of facilities and equipment.

$$\text{FIRM.VALUE} = \text{LAND} + \text{WCAP} + \sum_j \text{BOOK}_j$$

- Price Estimate

The financial model of the firm is solved to estimate a price for solar arrays. This price estimate includes a reasonable return on investment and is expressed in dollars inflated to the steady state manufacturing year. To facilitate comparisons with the JPL project goals, a price level adjustment is made to deflate it to base year dollars.



ANALYSIS

In this section, the SAMICS theoretical model is analyzed. Several opportunities for strengthening the formulation are identified. This analysis formed the basis for the recommendations presented in the following section.

The theoretical model is capable of meeting its objective to compare competing manufacturing processes on a standardized basis. In addition, several sensitivity analyses can be performed to assess the impact of economies of scale, industry structure, government policy actions, and management strategies.

Overall, the model is theoretically sound, subject to the constraints of its intended scope. The formulation is restricted to the supply side of the market avoiding the interactions of supply and demand. The model is also static in the sense that it does not include the effects of industry growth on capacity expansion.

LONG-RUN AVERAGE COSTS

The SAMICS steady state cost calculations assume that all costs including capacity expansion are completely variable. Whereas, short-run costs are predicated on a given set of facilities and production techniques that cannot be changed over a short period of time, long-run cost estimates are based on a period of time sufficiently long so that all factors affecting costs and output may be considered completely variable.

The implications of this long-run cost assumption on the optimal scale of operation and the industry structure are analyzed in Appendix D. As pointed



out, the SAMICS output will approximate a long-run average cost curve for each of the alternative manufacturing processes for producing photovoltaic solar arrays. This analysis will indicate the economies of scale available in purchasing, facility construction, and process automation.

SHORT-RUN COST VARIATIONS

Long-run cost functions are a valuable management tool for strategically planning the optimal scale of operation as well as for the selection among competing manufacturing processes. However, it is also important to consider the short-run cost variations in determining the industry size. Analysis of this variation will indicate how costs change when the plant is not operated at its design level.

When a production process is in the design stages, the expected rate of production for a given design level is really uncertain and will not be known until the process has been operating for some period of time. In the case of the SAMICS model industry, the firm to be designed could be composed of several processing facilities in series. The uncertainty associated with each facility's expected output rate will affect the expected industry output rate.

To improve the control of costs and the investment risk in a multi-firm industry, it is necessary to know the magnitudes of possible short-term cost variations associated with different facility sizes. As mentioned in Appendix D, the model contains provisions for determining the short-run cost variations by changing the process usage fractions and the number of operating shifts per day.

56
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OF POOR QUALITY

INDUSTRY STRUCTURE

The SAMICS assumptions regarding industry structure have been defined ambiguously. In the SAMICS long-run cost analysis, the manner in which facility size varies with output volumes is of primary interest. However, the extent of horizontal and vertical integration will also influence the number and size of the individual plants. These factors have significant consequences for the long-run cost variations being estimated.

The model is capable of assessing the impact of vertical integration most easily, but, with a slight extension, horizontal integration could also be examined. If warehousing and distribution functions are added, this analysis may indicate diseconomies of scale after a certain scale of operation.

INDUSTRY GROWTH

In a flow-shop manufacturing environment such as the proposed solar array manufacturing industry, the initial design capacity decision involves a major capital investment. Similarly, capacity expansion will involve the retirement and replacement or the addition of equipment and facilities at a substantial capital investment.

In this context, the optimal initial size and scale of facilities and a strategic plan for capacity expansion are financially important considerations. The dominant variable influencing these decisions is the expected demand for the firm's product translated into capacity requirements over time.

The SAMICS model treats demand statically, varying over a specified range. The initial plant design capacity is based on a constant steady state production rate over the life of the facilities. However, demand is seldom static and the long-term growth pattern is especially important for a new

product. The demand for solar arrays can be expected to follow the classical S-shaped growth pattern over time. This pattern begins with a slow but steady growth, is followed by a rapid growth phase, and ends with a saturation period when the market stabilizes.

These capacity expansion policy considerations are discussed in greater depth in Appendix E. Clearly, the economics of this decision involves several trade-offs. The fundamental issue is the size and timing of present and future demand estimates and the corresponding cash flow requirements.

MANUFACTURING PROCESS MODEL

The manufacturing process model is theoretically straightforward. The only potential problem lies in isolating the direct requirements for each machine. These are the materials, facilities, personnel, and utilities directly required to operate a specific machine. The distinction becomes difficult when the same type of facility is required by more than one machine. The fraction of the facilities for each machine are specified separately and then added to obtain the total facilities required. This process may lose some of the potential economies of scale.

FACTORY CONSTRUCTION AND STAFFING ALGORITHM

The factory construction and staffing algorithm contains several opportunities for simplification. The size of the indirect requirements matrix, R , could be so large that the inversion is a formidable task. However, the fact that many of its rows may contain all zero entries since some indirectly required items require no additional items. The effects of the associated columns are then dealt with separately, thereby reducing the rank of the matrix to be inverted. Theoretically, the $(I - R)$ matrix must be non-singular for the inverse to exist. In practice, this is not likely to be a problem.

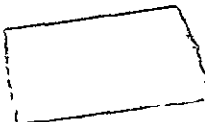
Potentially, there are a large number of indirect requirements relations to specify. This task can be simplified by identifying the most significant relationships and by aggregating certain items. For example, pens, paper clips, paper, etc. can be combined into a commodity called office supply dollars, whose quantity is approximated as a function of the administrative staff requirements.

The assumption that the number of orders produced by a salesperson per year is independent of the product size could be improved. Presumably, a salesperson could be expected to sell a large number of small arrays but only a few commercial power generating arrays.

A better approach might be to assume that each salesperson can sell a fixed number of panels. This would imply many orders for small arrays composed of a few panels and few orders for large arrays composed of many panels. Alternatively, the number of salesmen could be specified as a tabular function of the product order size.

LAND VALUE

The solar array price estimate could be reduced by altering the method of land valuation. The SAMICS procedure assesses the book value of land at its inflated market value. The Generally Accepted Accounting Procedure assigns the book value as the minimum of the purchase price and the fair market value. For a positive land inflation rate, the SAMICS method overstates the generally accepted accounting book value. The effect of this assumption is higher property taxes, insurance, and debt interest, leading to a higher cost of producing arrays.



FACILITIES CAPITAL COSTS

As mentioned in the preceeding section, the SAMICS model assumes for simplicity that the initial facility cost can be approximated as the sum of functions of the individual facilities items. That is, the total facilities cost is computed as the sum of the separate facilities component costs.

The validity of this assumption can be tested by comparing the model results with the facilities cost estimates for three alternative plant designs which will be provided by the SAMICS support study.

BY-PRODUCTS

The SAMICS definition of by-products includes both sellable products (other than the firm's primary product) and pollutants which incur disposal costs. Due to the negative connotation associated with the word pollutant, pollutants are assigned negative "prices" and treated as revenue-generating by-products. Thus, the disposal costs are not included in the annual operating expenses.

A better approach would be to separate by-products into two categories: by-product expenses and by-product revenues. By-product expense items would include pollutant disposal costs and should be added to the annual operating expense. With this procedure, by-product revenues would not increase the firm's working capital requirements, but by-product expenses would.

ONE-TIME COSTS

The SAMICS model currently assumes that the plant construction phase is followed by a production start-up period. During this period costs are incurred and resources are consumed; however, the production rate is assumed

to be zero until steady state operation is reached, when the output level is equal to the design capacity. The start-up costs are treated as one-time costs and amortized over the life of the facilities.

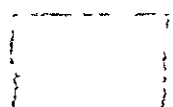
Several "revenue" cash flows, such as initial product revenues, investment tax credits, and job tax credits, could also be included to offset the one-time costs. This would lower the initial working capital requirements in addition to the eventual solar array price estimate.

The model could be expanded to accomplish this by incorporating the learning curve model for production start-up given in Appendix F.

GOVERNMENT ACTIONS

The impact of a variety of government actions can be assessed with the SAMICS model. The potential actions include changes in the tax rates, investment tax credits, subsidies for capital investment, low interest guaranteed loans, and changes in the inflation assumptions. Depending on the assumptions made, each of these actions could alter the eventual price of solar arrays. Thus, government policy alternatives are an important feature of the SAMICS model. This capability could be improved and expanded in two specific areas:

- 1) The IRS rules regarding investment tax credits differ slightly from the SAMICS model. The basic difference is that the credit rate allowed by the IRS varies as a three-level step function of the tax life rather than a linear function. The total investment credit is restricted by the firm's tax liability and a maximum credit rate depending on the qualified investment tax life. Provisions for carrying credits forward and backward are also available to allocate unused credit. The most recent IRS investment tax laws introduced by the Tax Reform Act of 1976 are explained in Appendix G.

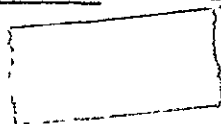


- 2) The proposed Tax Reduction and Simplification Act of 1977 provides a new job tax credit. Companies will be allowed income tax deductions for each net new employee hired. The credit is generally based on Federal Unemployment Tax Act (FUTA) wages (the first \$4,200 of an employee's wages) paid by an employer during the year. To limit the credit available to a new or rapidly expanding business, wages on which the credit is based are restricted to 50% of FUTA wages for the year. The details of this new credit are explained in Appendix H.

PLANT AND EQUIPMENT REPLACEMENT ASSUMPTION

The SAMICS model assumes that the replacement of plant and equipment continues forever. In practice, this situation is not likely to occur. As demand grows, plants are likely to be expanded by parallel additions of equipment rather than by replacement of old equipment with a larger-sized unit. All essential equipment will be replaced until continued operation cannot justify the replacement expenditures economically. Thus, the process becomes increasingly unprofitable and the plant will finally be scrapped when a major piece of equipment requires replacement.

The "replacement forever" assumption is justified for the following reason: the production life that we are dealing with is relatively long, say greater than 30 years, so that the present value of assumptions about termination of plant and equipment are not very important. For example, at a capital cost of 10%/year, the present value of a \$100/year for 30 years is \$942.46; while the present value of \$100/year forever is only 6% more, or \$1000.



Thus, the "replacement forever" assumption yields as accurate results as any other arbitrary assumption of plant life, and it avoids the difficulties of making an explicit prediction of the cash flows occurring at the time when the plant is scrapped or sold. However, if new technological developments are likely to occur rapidly, making the plant obsolescent in a short period of time, then this replacement forever assumption will not be valid. This situation is quite possible in the case of a new and untested product such as the solar arrays.

If new materials and superior processes are developed in the near future, obsolescence will be accelerated. This possibility has a significant impact on the design capacity and expansion policy. For these reasons, a careful assessment of the expected plant life is critical.

However, since the initial technology for producing solar arrays has not really been developed yet, a detailed analysis of the impact of new technology could only be a superficial treatment. At this stage, the best way to treat this factor would be to limit the likely capital recovery period and retain the current replacement assumption. For example, a period of five to ten years should be used, whereas ten to fifteen years would be appropriate for a mature technology.



RECOMMENDATIONS

The following paragraphs contain a summary of the recommendations for the SAMICS theoretical model, based on the preceding findings and analysis. Implementation of these recommendations will strengthen the SAMICS theoretical model capabilities.

LONG-RUN AVERAGE COST CURVE

A long-run average cost curve could be approximated with the SAMICS model output for each of the alternative solar array manufacturing process sequences. One of these sequences may prove superior over all ranges of output. However, more probably the optimal process will vary with the facility size. In this case, an estimate or probability distribution for the demand will indicate which process should be selected to minimize the long-run average cost.

SHORT-RUN COST VARIATIONS

The SAMICS model should be capable of analyzing the short-term cost variations due to uncertainty in process capacity. Analysis of this variation will indicate how costs change when the plant is not operated at its design level. To accomplish this, the machine process usage fractions and the number of shifts per day could be varied for each level of industry scale. The operating costs resulting from each of these variations would approximate the short-run average cost curves associated with different facility. From this information decisions regarding the optimal manufacturing process and scale of operation could be made more prudently. However, at this stage, it would be more practical to simplify the matter by treating process capacity deterministically.

INDUSTRY STRUCTURE

In the SAMICS long-run average cost analysis, the manner in which facility size varies with output volume is of primary interest. Thus, it is critical that the industry structure be more precisely defined with respect to the extent of horizontal and vertical integration for the long-run cost variations being estimated. For a given level of production, the industry structure will have significant consequences on the results.

INDUSTRY GROWTH

Ultimately, the initial plant design should include the selection of the production process, plant size, location, extent of integration, and a plan for expansion, as well as the anticipated timing of the cash flow requirements. As pointed out, these industry growth considerations depend on the size and timing of demand forecast which are currently beyond the scope of the SAMICS model.

At some point in the future, the model should be expanded to analyze the interaction of supply and demand over time. Such a dynamic model would provide the capability of examining the implications of industry growth and alternative capacity expansion policies on the eventual price of solar arrays and the attractiveness of the investment.

ONE-TIME COSTS

The model of one-time costs should account for start-up production revenues, investment tax credits, and employment tax credits, as well as the start-up costs. A learning curve model for production start-up is provided in Appendix F. These factors should be combined to develop a refined treatment of one-time costs later in the SAMICS study.

LAND VALUE

To conform with Generally Accepted Accounting Principles, the value of land should be the minimum of purchase price and market value. For a positive land inflation rate, this will equal the purchase price.

FACILITIES CAPITAL COSTS

The facilities capital cost estimates for three conceptual plant designs should be made as independently as possible from the model's facilities cost estimating relationship. This will ensure a valid test of the model's algorithm for computing the initial cost of facilities.

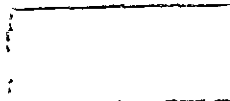
BY-PRODUCTS

By-products should be separated into two categories corresponding to revenue generating products and pollutants. The cost of disposal for pollutants should be treated as an operating cost rather than a negative revenue.

GOVERNMENT POLICY ACTIONS

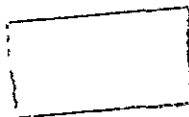
The Investment Tax Credit model should be modified to reflect the revisions of the 1976 Tax Reform Act. A model for doing this is presented in Appendix G.

The model should be extended to include a Job Tax Credit. This new credit, if introduced by the Tax Reduction and Simplification Act of 1977, could have significant tax consequences for new or rapidly expanding businesses. The implementation of a Job Tax Credit model would expand the number of government policy actions which SAMICS can analyze. The proposed Employment Tax Credit is explained in Appendix H.



PLANT EQUIPMENT AND REPLACEMENT

The capital recovery period should be restricted to five to ten years to allow for technological obsolescence. Since better manufacturing processes will be developed rapidly, potential investors will require a shorter capital recovery period to reduce the risk.



STANDARD
FINANCIAL PARAMETERS

INTRODUCTION

This section contains a description and analysis of the Solar Array Manufacturing Industry Costing Standards (SAMICS) financial parameters. These standard parameters provide a basis for the evaluation and comparison of alternative manufacturing processes. Exhibit I summarizes the SAMICS financial parameters as they are presented in the workbook. For the purposes of this critique, the parameters have been divided into ten categories:

- 1) Investment Tax Credit Parameters
- 2) Depreciation Parameters
- 3) Corporate Tax Rates
- 4) Discount Time Factors
- 5) Price Level Adjustment Parameters
- 6) Capital Discount Rate Parameters
- 7) Miscellaneous Cost Factors
- 8) Production Turnover Time Lags
- 9) Land Value Parameters
- 10) Energy Consumption Factors

In the following paragraphs the standard financial parameters in each category are described and analyzed. Several revisions are recommended to conform with IRS tax laws and Generally Accepted Accounting Principles. Adoption of these recommendations will strengthen the SAMICS cost comparisons.

EXHIBIT I

SAMICS STANDARD FINANCIAL PARAMETERS

PART I

Symbol	Value	Name	Description
α	7%	Investment Tax Credit	Income tax incentive for investment (a partial investment subsidy)
β	2%	"Other" Tax Rate	Non-income taxes as a fraction of capital
γ	20%	Solar Energy Usage Factor	Ratio of average power produced by modules to peak power, for use in calculation of energy pay-back time
Γ	0.5704	PBT Factor	Conversion factor for energy pay-back time
			$\Gamma = 1000 \frac{\text{kW}}{\text{W}} / \left(\gamma \times 8766 \frac{\text{hr}}{\text{yr}} \right)$
δ	6%	One-time Cost Fraction	One-time costs as a fraction of facility capital
λ	2	Leverage	Ratio of total capital to equity
μ_{book}	"SL"	Book Depreciation Method	Defines book depreciation formula
μ_{tax}	"DDB"	Tax Depreciation Method	Defines tax depreciation formula
ν	4%	Insurance Rate	Insurance premiums as a fraction of capital
ρ	2/3	Tax Life Fraction	Ratio of minimum allowable tax life to expected real life
r	50%	Income Tax Rate	Combined federal and state corporate income tax rate
ϕ	6%	De-inflation Rate	Inflation rate used for returning manufacturing year dollars to base year dollars
Φ	1.8982	Deflator	Factor by which manufacturing year dollars must be reduced to obtain base year dollars
			$\Phi = (1+\phi)^{t_m - t_0}$
C_{land}	2000	Land Price	$t_{p,\text{land}}$ Price of land in \$/acre
$\text{CRF}(k, L_{\text{fac}})$	14.81%	Capital Recovery Factor	Factor to amortize costs over the life of the facility

$$\text{CRF} = k / (1 - (1+k)^{-L_{\text{fac}}})$$

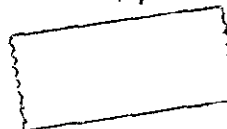
EXHIBIT I

STANDARD FINANCIAL PARAMETERS

PART 2

Symbol	Value	Name	Description
g_{fac}	6%	Facilities Inflation Rate	Rate of inflation for facilities costs
g_{land}	7%	Land Inflation Rate	Rate of appreciation of land value
i	9%	Debt Interest Rate	Rate of interest paid on corporate bonds
IN.LAG	0.04 years	Raw Materials Inventory Time	Time raw materials spend in in-coming inventory
ITC.BOT	3 Years	Investment Tax Credit Bottom Life	Maximum tax life for no investment tax credit.
ITC.TOP	8 years	Investment Tax Credit Top Life	Minimum tax life for full investment tax credit.
k	14.75%	Cost of Capital	Internal rate of return. The weighted average after-tax cost of capital $k = (1-\tau)(\lambda-1)i/\lambda + r/\lambda$
L_{fac}	40 years	Facility Life	Time during which facilities are gradually replaced
OUT.LAG	0.04 years	Finished Goods Inventory Time	Time finished goods spend in inventory.
PAY.LAG	0.17 years	Payment Float Lag	Average time between departure of the firm's product from finished goods inventory to receipt of payment.
r	25%	Rate of Return on Equity	Required rate of return on investors' capital
t_m	1986	Manufacturing Year	Year in which the manufacturing takes place, all prices are calculated for this year.
t_0	1975	Base Year	Year for price comparisons, especially with respect to goals
$t_{p,land}$	1975	Land Price Year	Year for which C_{land} is an appropriate price estimate
x	5%	Miscellaneous Expense Fraction	Miscellaneous expenses as a fraction of revenue
XLAG	2	Processing Time Multiplier	Passage time through the factory as a multiple of actual processing time

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CRITIQUE

1) Investment Tax Credit Parameters

- SAMICS Model

The SAMICS model computes an investment tax credit separately for all equipment and facilities based on the annual investment and related tax-life. To accomplish this, the following standard financial values are used.

$\alpha = 7\%$ = Investment Tax Credit Rate

ITC.BOT = 3 years = Maximum tax life for no investment tax credit

ITC.TOP = 8 years = Minimum tax life for full investment tax credit

- IRS STANDARDS

As a result of the Tax Reform Act of 1976, the Federal Investment Tax Credit rate for qualified investments was raised from 7% to 10%. The credit period was extended to cover property acquired or constructed between January 22, 1975 and December 31, 1980. Also, the minimum tax-life necessary to receive full credit was reduced from 8 years to 7 years.

In general, Investment Tax Credit earned may be applied up to a maximum of 50% of the current year's Federal Income Tax liability. All unused credits are able to be carried forward seven years or carried back three years.

The Investment Tax Credit of 10% has limitations if the qualifying property has a tax-life of less than seven years:

- i) No credit is allowed if the tax-life is less than three years.
- ii) $\frac{1}{3}$ of the credit may be claimed if the tax-life is greater than or equal to five years and less than seven years.
- iii) $\frac{2}{3}$ of the credit may be claimed if the tax life is greater than or equal to five years and less than seven years.
- iv) Full credit is allowed if the tax-life is seven years or more.

An additional 1% tax credit may be claimed if an equivalent amount is contributed to an employee stock ownership plan. Similarly another .5% is permitted if employee contributions equal the .5%.

These Investment Tax Credit rules are explained in greater detail in Appendix G. Several opportunities exist for improving the SAMICS investment tax credit treatment to reflect the Tax Reform Act of 1976.

• Investment Tax Credit Recommendations

As mentioned previously, the Tax Reform Act of 1976 raised the base rate to 10% and extended the credit period through 1980. The SAMICS model implicitly assumes that the credit period will be extended beyond 1980 because the standard value for the manufacturing year is 1986. This is the year in which the steady state manufacturing takes place. All costs are computed for this year. Since tax laws are frequently extended, this is a reasonable assumption. However, the credit rate should be increased to 11% with the assumption that 1% is contributed to owners' equity.

The financial model should be expanded to include parameters for the maximum allowable investment credit. The IRS minimum tax-life for $\frac{1}{3}$

credit is equal to the SAMICS maximum tax-life for no Investment Tax Credit. The IRS minimum tax-life of five years for 2/3 Investment Tax Credit should be added and the SAMICS minimum tax-life of eight years for full Investment Tax Credit should be reduced to the IRS revised value of seven years.

In summary, the following standard Investment Tax Credit parameters are recommended:

α = Maximum Investment Tax Credit Rate
(11%)

ITC.BOT = Minimum tax-life for 1/3 investment tax credit
(3 years)

ITC.MID = Minimum tax-life for 2/3 investment tax credit
(5 years)

ITC.TOP = Minimum tax-life for "full" investment tax credit
(7 years)

MAX.ITC = Maximum Investment Tax Credit
50% (Federal Tax Liability)

Recommendations for incorporating these variables in the SAMICS model are presented in Appendix H.

2) Depreciation Parameters

The SAMICS financial model includes parameters for accounting for depreciation. These parameters are intended to amortize the costs of depreciable assets, less their projected salvage values, over their estimated useful lives. In effect, the costs incurred for facilities and equipment are viewed as a prepaid expense to be apportioned according to the respective years of service. The standard depreciation parameters

are defined as follows:

μ Book	= Book Depreciation Method - Straight Line
μ Tax	= Tax Depreciation Method - Double Declining Balance
L Facility	= Facility Life = 40 years
ρ	= Tax Life Fraction = $2/3$
g Facility	= Facilities Inflation Rate = 6%

Different depreciation methods are utilized for financial reporting (book values) and tax purposes. The book depreciation method is used to allocate the cost (book values) of the facilities and equipment, for financial reporting purposes over the useful lives of the assets, while the tax depreciation method is used to compute allowable income tax deductions generated from an accelerated depreciation of the assets. The facilities life is the time over which the depreciable assets are depreciated. The tax-life fraction is the ratio of the tax-life to the expected physical life of the facilities and equipment. The facilities inflation rate is used to compute the depreciation of assets entered on the books at lower purchase prices.

• Depreciation Methods

The straight line method is the simplest and most widely used method of computing depreciation. Under this method an equal portion of the cost of an asset is allocated to each period of use. Consequently, this method is most appropriate for Financial reporting (book value) purposes assuming that the usage of assets will be fairly uniform from year to year.

The double-declining balance method is referred to as an accelerated method because depreciation is greatest during the early years of an asset's life and correspondingly less in the later years. This method is appropriate for an industry undergoing rapid technological changes making obsolescence a more significant factor than physical deterioration.

In this situation accountants reason that the acquisition of a new facility is justified only if most of the cost can be recovered within a comparatively short period. However, the negative impact of obsolescence diminishes when the useful life of an asset for tax depreciation purposes is calculated at less than the expected physical life. The IRS, generally speaking, allows a ratio of 2/3 for the minimum allowable tax-life to the expected real life. This value is also currently used in SAMICS.

Another argument for allocating a comparatively large share of the cost of a depreciable asset to the early years is that maintenance and repair costs tend to increase over time. An accelerated depreciation method, such as double-declining balance, will offset the rising repair costs with decreasing depreciation costs. Thus, the combined expense of depreciation and repairs may be more uniform over time under the declining-balance method than when the straight-line method is applied.

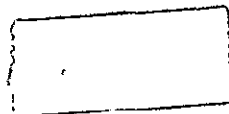
In recent years the double-declining depreciation method has become increasingly popular for income tax purposes. By offering businesses the opportunity to write off a large portion of the cost of a new asset during its first years of use, the IRS provides a strong

incentive for investing in new production facilities. Since the larger depreciation expenses will reduce taxable income, the investor can in effect pay for the new assets with dollars that would have otherwise been paid as taxes.

However, if the company's taxable income is expected to be low during the initial years due to startup operations, then it would be more beneficial to defer the depreciation charges to later years when the taxable income will be higher.

In theory, the ideal accounting depreciation policy is one that allocates the cost of an asset to the periods of use in proportion to the services rendered each period. Accelerated methods may fail to allocate the cost of an asset in proportion to the flow of services and therefore prevent the determination of annual income on a realistic basis. If the asset values reported on the company's financial statements are misleading, potential stockholders, creditors, and financial analysts will not be able to properly interpret the statements for investment decisions.

For income tax purposes, however, the declining-balance method of depreciation may encourage businessmen to invest in new productive facilities. On the other hand, it may be more beneficial to defer depreciation expenses to offset higher taxes in later years when the firm is operating at its capacity.



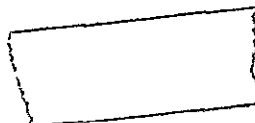
• Useful Life of Facilities

The service life of facilities for accounting purposes is viewed as the number of years elapsing from an asset's acquisition to its final disposition, regardless of the different uses to which the facilities may have been put during these years. This is the view, established by the IRS, governing income tax laws.

In 1962 the U. S. Treasury Department published "guideline lives" for many broad classes of business assets. The use of these lives for income tax purposes is subject to certain restrictions. In general, a tax-life of 25 to 45 years is appropriate for most manufacturing facilities. It is also possible through an ADR (Asset Depreciation Range) to elect to use relatively shorter lives for tax purposes than the actual life used for accounting purposes. Thus, the SAMICS useful life of 40 years for facilities and a tax-life fraction of $\frac{2}{3}$ are consistent with Generally Accepted Accounting Principles and IRS standards. These values result in a facilities tax-life of 27 years.

• Facilities Inflation Rate

Under the double-declining balance method allowable by the IRS for income tax purposes, the depreciation rate is typically computed as 200% divided by the useful life in years for equipment and 150% for buildings. This 200% rate is essentially double the straight-line rate.



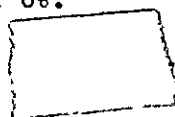
In computing the permissible declining balance rate, any prospective salvage value is disregarded. Based on the SAMICS value for the life of facilities (40 years), the computed rate would be 3.75% for buildings. The rate for equipment will vary with the corresponding useful lives. While this depreciation rate remains constant, the facilities inflation rate will fluctuate between 7 and 8%.

In the practical use of the declining balance method, it is better to select a depreciation rate consistent with the anticipated inflation of facilities than to compute a rate from a standard formula.

The double-declining balance rates allowed by the IRS are intended to permit a write-off of about 2/3 of the cost of an asset during the first half of its estimated useful life.

- Recommended Depreciation Parameters

The double-declining balance depreciation method should be used as the standard for income tax purposes. However, the construction and startup costs may be substantial enough that it would be beneficial to defer the income tax savings to later years. If preliminary results indicate this to be true, then a straight-line method should be used for both Financial Reporting (book value) accounting and income tax purposes. An alternative method would be to use a straight line rate with inflation to adjust for the increase in replacement cost each year. This method is referred to as a sinking fund or reserve for facilities. The projected replacement cost is obtained by cumulatively increasing the straight line rate by the inflation rate each year. The result is 100% the first year, 106% the second, 112.36, 119.10, etc. for a facilities inflation rate of 6%.



3) Corporate Tax Rates

• SAMICS Standard Values

The SAMICS model employs two tax rates with the following standard values:

- i) γ = Income Tax Rate = 50%
- ii) B = "Other" Tax Rate = 2%

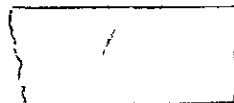
The income tax rate combines both federal and state corporate income tax rates of 48% and 4%, respectively.

The "other" tax rate relates non-income taxes, such as real estate and personal property taxes, to the capital value of firm's assets.

• IRS Corporate Income Tax Rates

The 1976 federal tax rates on corporate income were generally 20%, 22%, and 48% depending on the amount of taxable income and whether the corporation was a member of a "controlled" group. Disregarding the special rates that applied to controlled group members, the tax rules can be simplified by stating that the first \$25,000 of income was taxed at the nominal rate of 20%, all income above \$25,000 was taxed at 22%, and a surtax rate of 26% was applied to income exceeding \$50,000.

Thus, the incremental federal tax rate was 20% for small corporations with taxable incomes below \$25,000 and 48% for medium and large corporations.



Most states also collect corporate income taxes. However, these rates vary considerably from one state to another. For California the rate is currently 9%.

- Effective Combined Tax Rate

Economic studies are simplified when a single effective tax rate can be applied to combine the tax rates imposed by different government units. The appropriate rates for combining tax rates depend on the way in which the tax payments to different government units influence the taxable income reported to the others. For example, state corporate income taxes are deductible from federal taxable income. Conversely, federal income tax deductions are not allowed in most states.

A simple formula for combining state and federal incremental tax rates may be given for the common case where the state tax is deductible on the federal return but the federal tax is not deductible on the state return.

Let S represent the state tax rate expressed as a decimal.

Let F represent the federal tax rate expressed as a decimal.

Then, the effective combined income tax rate is given by:

$$Y = [S + (1-S) F] * 100\%$$

Substituting $S = .09$ and $F = .48$ yields

$$Y = 52.68\%$$

Traditionally, a 50% effective tax rate has been used in economic studies where the annual taxable income was expected to be greater than \$50,000. This single rate has the advantage

of simplicity and allows for a 48% federal tax and a 4% state tax. However, a 50% rate is not a good one if the anticipated income is less than \$50,000 or the state tax rate is substantially higher than 4% as it currently is in California.

The effective combined income tax rate should be calculated explicitly from the federal and state tax rates to allow for the variation in the state rates. This could be done easily in SAMICS using the preceding formula. A standard value of 9% for the state income tax rate would also be better than the current implicit value of 4%. 9% would be representative of the California tax laws. A non-income tax of 2% times the capital value of the firm is commonly used in economic analyses. Thus, the SAMICS standard value for this parameter is justified.

● Recommended Tax Rates

In summary, the following standard values are recommended for the SAMICS corporate tax rates.

$$F = 48\%$$

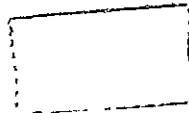
$$S = 9\%$$

$$T = S + (1-S)F = 52.68\%$$

$$B = 2\%$$

4) Discount Time Factors

Four standard time factors or years are required by SAMICS as a basis for amortizing costs and forecasting the future profitability of the potential industry. These factors are defined as follows.



t_o = Base Year = 1975
t_c = Initial Construction Year
t_s = Production Startup Year
t_m = Manufacturing Year = 1986

All steady-state manufacturing price estimates are discounted to the base year for comparisons with the project goals. The initial construction year is the year in which construction of the factory begins. Similarly, the production startup year is the year in which construction is completed and productions operations begin. The manufacturing year is the year for which production cost calculations are made assuming operation at the design capacity. Standard values have not yet been assigned for the initial construction year and the production startup year. These values will be estimated later in the study.

The JPL solar energy project goals were established in 1975 and expressed in 1975 dollars. The specific goal is to reduce 1975 solar array prices of \$20,000 - \$25,000 per kilowatt for annual production quantities of 100 kilowatts to less than \$500 per kilowatt for annual production quantities of 500 kilowatts by 1986.

Thus, the standard values for the base year and the manufacturing year (1975 and 1986 respectively) are consistent with the statement of the project goals. Since these goals were established in 1975 and expressed in 1975 dollars, valid comparisons can be made, if price estimates are discounted to 1975. A manufacturing year of 1986 will indicate the feasibility of attaining the goals by that time.

The critical assumption is that this time span is sufficiently long for steady-state operation to be reached. Even though the construction lead time and the production startup times have not been estimated, this assumption is valid provided that construction actually begins around 1980. This would allow five or six years for construction and startup.

5) Price Level Adjustment Parameters

All SAMICS price estimates for the manufacturing year are discounted to base year dollars. To accomplish this, the following de-inflation rate parameters are applied:

$$\phi = \text{De-inflation Rate} = 6\%$$

$$\overline{\Phi} = \text{Deflator} = 1.8982$$

The deflator is computed from the de-inflation rate, the base year (t_0) and the manufacturing year (t_m) using a standard present worth relationship:

$$\begin{aligned} \overline{\Phi} &= (1 + \phi)^{\frac{t_m - t_0}{1}} \\ &= (1.06)^{1986-1975} \\ &= 1.8982 \end{aligned}$$

The prices and costs expressed in dollars inflated to the manufacturing year, are divided by this deflator to obtain base year dollars.

Beginning in 1978, the governing body of the accounting profession, the Financial Accounting Standards Board (FASB), will require that this type of price level disclosure accompany all audited financial statements, to reflect the effect of inflation on current and projected earnings.



The standard de-inflation rate of 6% is lower than recent and anticipated inflationary trends. A value of 7% would be more representative of these trends.

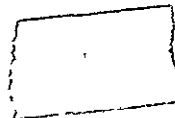
The manner in which prices are deflated is consistent with Generally Accepted Accounting Principles and projected IRS requirements.

6) Capital Discount Rate Parameters

The SAMICS model applies three capital discount rate parameters which specify the internal rate of return and the external cost of capital for the hypothetical manufacturing enterprise.

r	= Rate of Return on Equity	= 25%
k	= Cost of Capital	= 14.75%
$CRF(k, L_{fac})$	= Capital Recovery Factor	= 14.81%
L_{fac}	= Facility life	= 40 years

- The rate of return on equity is the rate assumed to be required by the potential investors and is used to compute a profit for the solar array manufacturing company.
- The cost of capital is the company's internal rate of return defined as the weighted average after-tax cost of capital computed from the income tax rate, T , the financial leverage ratio, λ , the debt interest rate, i , and the rate of return on equity r .
- The capital recovery factor is used to amortize all one-time cash flows over the estimated life of the facility. The one-time cash flows associated with construction and production startup include land purchase, site preparation, interest during construction,



Investment Tax Credits, and initial operating costs and revenues.

- Rate of Return on Equity

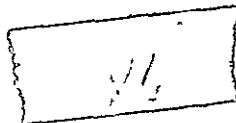
In most economic studies the rate of return on equity is computed from estimates of the total production cost and the market price. However, in the SAMICS procedure the company's profit is computed from the total production cost and the desired rate of return on equity. In doing this, it is important to assess the reasonableness of the assumed rate of return as it effects the eventual price estimate, and the investment risk.

An after tax rate of return of 25% reflects a very strong earning power. Since the ultimate test of a company's success is its ability to earn a return on the investments, this rate is a central measure of the company's overall profitability.

- Cost of Capital

The after tax cost of capital is not really an independent standard parameter since it is computed directly from the income tax rate, the debt interest rate on corporate bonds, the financial leverage ratio, and the rate of return on equity.

The formula is valid, however, the results depend on the standard values of these parameters which are analyzed elsewhere in this section.



- Capital Recovery Factor

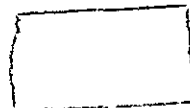
Similarly, the capital recovery factor used to amortize one-time cash flows is a standard discount factor based on the computed cost of capital and the estimated life of the manufacturing facility. Hence, the size and timing of the one-time cash flows will have a significant impact on the steady-state price estimate for the solar arrays. This factor is highly dependent on the rate of return on equity and the time period used.

The assumed rate of return on equity of 25% should be carefully assessed to ensure that a realistic price estimate is obtained. Along with the debt interest rate, this rate of return directly influences the computed cost of capital and the capital recovery factor of the firm.

For a new industry with a rapidly changing technology such as the proposed solar array manufacturing industry, the capital recovery period required by potential investors will be much shorter than the estimated useful life of 40 years. The common practice is to require between five and ten years for capital recovery. This will compensate for the investment risk associated with premature obsolescence.

7) Miscellaneous Cost Factors

The SAMICS financial parameters include several cost factors to estimate the overhead expenses of the company.



ϕ = One-time Cost Fraction = 6%

\checkmark = Insurance Rate = 4%

i = Debt Interest Rate = 9%

λ = Financial Leverage Ratio = 2

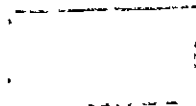
X = Miscellaneous Expense Fraction = 5%

The one-time cost fraction expresses the one-time costs incurred to construct and startup a factory as a fraction of the initial facilities capital costs. Although it is still listed in the workbook, this parameter will be removed from the SAMICS methodology with the introduction of a more detailed treatment of one-time cost cash flows.

Annual insurance premiums are approximated as a constant fraction of the capital book value of the company. The debt interest rate is the rate of interest paid on corporate bonds. The amount of interest is estimated by multiplying the total debt of the company (including current liabilities) by the debt interest rate. To do this, the total debt of the company is approximated from the total capital value and the financial leverage ratio.

$$\text{Leverage} = \frac{\text{Total Capital Value}}{\text{Total Equity}}$$

The miscellaneous expenses are defined as all those expenses not accounted for elsewhere, and are approximated as a constant fraction of the company's total revenue.



- Insurance Rate

The insurance rate of 4% of the capital value should yield a realistic estimate of the company's insurance premiums.

- Debt Interest Rate

The debt interest rate on corporate bonds is a function of the type and distribution of bonds. Bonds may be issued in many forms, containing varying provisions and privileges. For SAMICS' purposes it is unnecessary to be concerned with the detailed features of specific bond issues or their methods of distribution.

The important element is the proper interest rate. This is closely related to the expected prime rate of interest on the date of issuance for the following reasons.

If the bond rate is lower than the rate required by investors in the financial markets, then the bonds effectively must sell at a discount. This is necessary to stimulate investment when there are alternatives offering a higher rate. Conversely, if the nominal bond rate is higher than the market rate, the bonds will sell at a premium for more than the face value. Thus, the bonds will be issued at its maturity value only if the contractual interest rate is equal to the market rate. Recently, the prime market interest rate has been fluctuating around 9 1/4%.

- Financial Leverage

Financial leverage can increase the rate of return on stockholders' equity by using debt to finance part of the company's assets.

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To accomplish this, management employs capital supplied by creditors in lieu of stockholders' equity in expectation that the company will earn more on borrowed capital than the bond interest charges. If so, the excess goes to the stockholders, thereby increasing the rate of return on their investment.

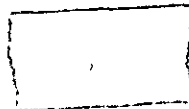
The extent to which a company can safely employ financial leverage is a function of the risk associated with its profitable operation. The favorability of this leverage depends on the differential between the actual earning rate on total assets and the debt interest rate. A leverage rate of two is a safe assumption for the potential solar array manufacturing industry.

- Miscellaneous Expense Fraction

Three types of miscellaneous expense accounts are generally accepted for manufacturing concerns: selling expense, general expense, and factory cost. Each of these typically depend on fixed and variable operating costs.

Selling expense is variable and usually varies with the level of product sales. General expenses are both fixed and variable. The fixed portion is a function of the facilities capacity while the variable portion is a function of production costs. In view of this, expressing miscellaneous expenses as a fraction of operating costs may be a better approach.

The price estimates for solar arrays will be quite sensitive to the value used. Thus, a careful review is required.



- Recommended Cost Factors

In summary, the miscellaneous cost factors have been assigned appropriate standard values. The insurance rate of 4% and the leverage ratio of 2 are valid. The debt interest rate on corporate bonds should be set at the prime market rate which has been close to 9 1/4%. The miscellaneous expense fraction should also be expressed as 4% of the annual operating costs rather than the revenue.

8) Production Turnover Time Lags

Several time lags are used in SAMICS to estimate the amount of working capital required to finance the production operation. As described below, these time lags relate to the various intervals between payment for raw materials and the payment for the finished products.

The standard values are expressed as a decimal fraction of a year.

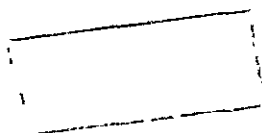
IN.LAG = Raw Materials Inventory Time = .04 years
(14.6 days)

X.LAG = Processing Time Multiplier = 2

OUT.LAG = Finished Goods Inventory Time = .04 years
(14.6 days)

PAY.LAG = Payment Float Lag = .17 years
(61.2 days)

- The raw materials inventory time is defined as the average time between the payment for and the use of these materials rather than the physical inventory time.



- The processing time multiplier accounts for in-process inventory time lags as a multiple of the average time spent to process raw materials into finished goods. This overall processing time is obtained by summing the individual machine cycle times.
- The finished goods inventory time is the average time that finished products are warehoused before shipping.
- The payment float lag is the time between the shipment of finished goods inventory and receipt of payment from customers. Financial analysts refer to this as the accounts receivable turnover time.

- Raw Material Turnover Time

The SAMICS standard value for raw material time lag assumes 14.6 days between the payment for and use of these materials. The model does not explicitly account for a payment float interval for raw materials as it does for accounts receivable. However, assuming that these materials can be purchased on credit terms, the receipt of invoices can be expected to follow a poisson distribution with a mean inter-arrival time of half a month.

The nature of the raw materials and the potential economies of scale in purchasing the storage should be carefully reviewed. This exercise may prove that it would be better to model the raw material inventory time as a function of the industry scale.

For example, purified silicon is a major input material representing approximately 10% of the current solar array manufacturing cost at \$75/kg. At low production levels silicon

would be purchased semi-monthly. However, at high production levels, it may be more cost effective to purchase every two months.

- Processing Time Multiplier

The in-process inventory time varies with the type of manufacturing process. The machine processing cycle times are specified as input data and are multiplied by a time lag factor to account for machine downtime, in-process transportation and storage, and factory closed time per year.

/ This processing time factor is highly dependent on the product size and the degree of automation. The SAMICS standard value of two is applied for all product sizes and production levels. This value also implies a highly automated facility and is overly optimistic. The actual value may range from 10 in a small batch processing environment to 10 in a large automated factory.

A better approach would be to model the processing time multiplier as a tabular function of the product size and the production level. Data from existing manufacturing firms with similar products and varying degrees of automation could be reviewed to specify this function.

- Finished Goods Inventory Time

The SAMICS finished goods inventory time could be also modeled as a function of the potential customers, and product size, and the production level. For example, if the customers are willing to place advance orders for large solar arrays, the finished goods

inventory time could be shortened, thereby, reducing the working capital required. On the other hand, if household solar units are being produced, a larger inventory would be required to avoid delays.

The relationship between inventory turnover and gross profits per dollar of sales may be significant. A low inventory turnover time and a low gross profit rate frequently accompany one another. Although a low inventory turnover time is usually regarded as a good sign, it may also mean that the firm is losing sales by failing to deliver its product promptly.

The average finished goods inventory time should vary with the the solar array size and level of production. The time may range from 10 to 10² days. Further research in this area would enhance the SAMICS model.

- Payment Float Lag Time

The accounts receivable turnover time is computed as the ratio of total annual credit sales to the average balance in accounts receivable. As with the inventory time lags, this turnover time can be expected to vary with the customer and the level of production. The average time required to convert receivables into cash typically ranges from 45 to 60 days for most manufacturing firms. However, when the government is the primary customer, this time lag could reasonably be expected to range from 60 days on up.

- Inventory Turnover Time Recommendations

The inventory turnover times should be tailored to fit the nature of the company's manufacturing processes, input materials,

production level and customers. The problem is one of balancing the cost of holding inventories against the costs associated with shortages and delivery delays due to process failures. The costs associated with these times are also directly influenced by the method of inventory valuation and economies of scale in purchasing.

The SAMICS model will be improved with variable estimates for the inventory turnover times. Data from existing manufacturing firms will be reviewed to specify these time factors as a function of the product size and the level of production.

9) Land Value Parameters

The SAMICS standard financial data includes three parameters associated with the value of land.

C	= Land Price	= \$2000/acre
land		
t	= Land Price Year	= 1975
p,land		
g	= Land Inflation Rate	= 7%
land		

The SAMICS price of land in 1975 is low for practical purposes. Obviously, the value of land and its inflation rate varies substantially from one location to another.

For SAMICS the important point is that the same value is applied to evaluate each of the alternative manufacturing processes consistently. The proper value to use is a median value for developed industrial park property.

The hypothetical company can be viewed as a going concern which requires land to operate the factory. An initial cost is incurred for its

acquisition and it is carried on the books until the assets of the company are liquidated. The costs associated with the acquisition and possession of this asset are a small proportion of the overall/ operating costs. Although these one-time costs are amortized over the useful life of the facilities, they will probably not have a substantial influence on the solar array price.

The standard value of land should be a median for developed industrial parks in the continental United States. The appropriate value will be assigned later in the support study following an evaluation of statistical price information. A sensitivity analysis should be performed to indicate the impact of changing the value.

10) Energy Production Factors

The last set of SAMICS standard financial parameters relate to the power producing characteristics of the solar arrays. These factors are applied to estimate the energy pay-back time for alternative products.

\mathcal{J} = Solar Energy Usage Factor = 20%

Γ = Pay-back Time Factor = $.5704 \times 10^{-6}$

The solar energy usage factor is defined as the ratio of the average power produced by the modules to the peak power capacity. This usage factor is applied in energy pay-back time calculations.

In SAMICS the energy pay-back time is defined as the length of time

a solar module must operate to generate an amount of energy equal to that expended in its production. The pay-back time factor is a conversion factor to compute this energy pay-back time.

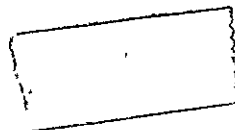
Given the peak power performance capacity in peak-watts per module and the energy usage factor, the pay-back time factor is expressed as:

$$P = \frac{10^3 \frac{\text{Kilowatts}}{\text{Watt}}}{J * (8766 \frac{\text{hours}}{\text{year}})} = .5704 \times 10^{-6}$$

From the standpoint of evaluating the energy efficiency of the proposed solar arrays, the energy pay-back time is an important concept. Since JPL has considerably more expertise to evaluate the standard energy factors, it is appropriate to rely on their skilled solar engineering judgment to assess the SAMICS values.

These standard factors are not really financial parameters. However, given a price for the energy produced, the price of the solar array, and the energy pay-back time factor, the financial pay-back time could be computed as the time required to recover the initial investment cost of the solar array. This will be an important marketing factor.

In the future as the scope of the model is extended to the demand side, the financial pay-back time for purchasing and operating a solar array could be modeled as it will influence the demand. The potential impact of other demand incentives, such as tax credits for installing solar units, could also be assessed.



APPENDIX A

PROJECTED INCOME STATEMENT

To make the SAMICS methodology and output more useful and understandable to the general business community, a projected income statement should be generated for the steady-state firm during the manufacturing year. This document summarizes the costs of operating a business and compares the enterprise's costs with revenues or income in a manner familiar to all managers and accountants. The generation of this document will require classifying all SAMICS cost according to generally accepted accounting principles. This cost accounting will insure that the SAMICS procedures conform with tax, financial, and legal requirements.

The income statement normally indicates the gross profit, net operating profit, and net profit after taxes resulting from operations during a given period of time. The format of this statement for a typical manufacturing firm is illustrated in Exhibit A 1. The cost of goods manufactured must be separately calculated from an analysis of factory labor, material, and indirect expenses as illustrated in Exhibit A 2.

The gross profit is obtained by subtracting the cost of goods sold from the net sales, (gross sales less sales returns, discounts, and allowances). Gross sales could be broken down into cash sales and credit sales based on the average collection time.

$$\text{GROSS} \bullet \text{PROFIT} = \text{NET} \bullet \text{SALES} -- \text{COST} \bullet \text{GOODS} \bullet \text{SOLD}$$

$$\text{NET} \bullet \text{SALES} = \text{GROSS} \bullet \text{SALES} -- \text{SALES} \bullet \text{ALLOWANCES}$$



EXHIBIT A1
SAMCO CORPORATION.

PROJECTED INCOME STATEMENT
FOR THE YEAR ENDING SEPTEMBER 30, 1986

Gross Sales

Less, Returns and Allowances

Net Sales

Less, Cost of Goods Sold:

Finished goods inventory, Oct. 1, 1985

Cost of goods manufactured (schedule A)

Less, Finished-goods inventory, Sept. 30, 1986

Gross Profit

Operating Expenses:

Selling Expenses:

Sales salaries and commissions

Sales office supplies

Advertising

Travel and Entertainment

Telephone and Telegraph

Other selling expenses

Provision for Doubtful Accounts

General and Administrative Expenses:

Salaries

Office supplies

Depreciation of office facilities

Insurance

Taxes

Other G&A expenses

Total Operating Expenses

Net Operating Profit

Other Income:

Income from Investment

Interest on Notes Receivable

Other Expenses:

Interest on Bonded Debt

Interest on Notes Payable

Net Nonoperating Income

Net Profit Before Income Taxes

Estimated Income Taxes

Net Profit after Income Taxes

100

EXHIBIT A2
SAMCO CORPORATION

SCHEDULE A

COST OF GOODS MANUFACTURED
FOR THE YEAR ENDING SEPTEMBER 30, 1986

Direct Labor

Direct Material:

Inventory, Oct. 1, 1985
Purchases (less returns)
Transportation cost of purchases
Total material available
Less, Inventory, Spet. 30, 1986
Material Used

Factory Expenses:

Indirect factory labor
Factory supplies
Maintenance and repairs
Utilities
Depreciation of factory facilities
Property taxes
Social Security Taxes
Insurance
Other Factory expense

Total Factory Costs

Change in work-in-process inventory:

Work-in-process inventory, October 1, 1985
Less, Work-in-process inventory, September 30, 1986

Cost of goods manufactured and delivered to finished-goods inventory

101

The gross sales can be approximated by the revenue currently estimated in SAMICS assuming that the computed price is the market price. The allowance for sales returns, discounts and allowances could be estimated as a fraction of gross sales for each firm's product. The cost of goods sold includes direct labor, direct material and factory expenses incurred to manufacture the products sold during the period. The computation of these costs is outlined below.

The net operating profit is obtained by subtracting operating expenses, consisting of selling, and administrative expenses, from the gross profit.

$$\text{NET} \bullet \text{OPERATING} \bullet \text{PROFIT} = \text{GROSS} \bullet \text{PROFIT} -- \text{OPERATING} \bullet \text{EXPENSES}$$

$$\text{OPERATING} \bullet \text{EXPENSES} = \text{SELLING} \bullet \text{EXPENSES} + \text{G\&A} \bullet \text{EXPENSES}$$

Selling expenses consist of items such as salesman salaries and commissions, advertising travel and entertainment, telephone and office supplies. G&A expenses include officer salaries, staff salaries, office supplies, depreciation of office equipment, insurance and taxes.

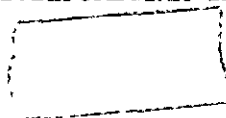
Next, non-operating income such as income from investments is reduced by non-operating expenses. An example of a non-operating expense is interest on bonded debt to obtain net non-operating income (loss). Net non-operating income is then added to net operating profit to estimate net profits before income taxes.

$$\text{NET} \bullet \text{PROFIT} \bullet \text{BEFORE} \bullet \text{TAX} = \text{NET} \bullet \text{OPERATING} \bullet \text{PROFIT} + \text{NET} \bullet \text{NON} \bullet \text{OPERATING} \bullet \text{INCOME}$$

$$\text{NET} \bullet \text{NON} \bullet \text{OPERATING} \bullet \text{INCOME} = \text{NON} \bullet \text{OPERATING} \bullet \text{INCOME} -- \text{NON} \bullet \text{OPERATING} \bullet \text{EXPENSE}$$

Finally, net profit after income taxes is computed by subtracting corporate income taxes from the net profit before taxes.

$$\text{NET} \bullet \text{PROFIT} \bullet \text{AFTER} \bullet \text{TAX} = \text{NET} \bullet \text{PROFIT} \bullet \text{BEFORE} \bullet \text{TAX} - \text{INCOME} \bullet \text{TAX}$$



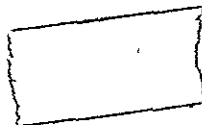
The calculation of the cost of goods manufactured for the income statement is illustrated in Exhibit A2. On this schedule, total factory cost is composed of direct labor cost, direct materials cost, and factory expense incurred during the period. This total factory cost is then adjusted to account for goods in process inventory resulting in the cost of goods manufactured and delivered to the finished goods inventory.

TOTAL•FACTORY•COST = DIRECT•LABOR + DIRECT•MATERIAL + FACTORY•EXPENSE

COST•GOODS•MFG = TOTAL•FACTORY•COST + WORK•IN•PROCESS

Factory expense, also called factory overhead, consists of all indirect operating expenses such as factory labor (supervisors, foreman, material handlers, crib attendants, dock clerks, etc.), employee vacation pay and fringe benefits, factory supplies (stationery, lubricants, janitorial and cleaning materials, etc.), maintenance & repairs, depreciation, taxes for machines, tools and buildings, utilities (heat, air-conditioning, light, water, power, etc.), and other miscellaneous items required for factory operation.

The SAMICS model currently accounts for most of these operating costs. However, in some cases they are classified and combined according to a scheme which will not be easily understood by management. It should not be too difficult to incorporate this standardized accounting system and to augment the model output with a projected income statement for the design manufacturing year. This capability will greatly enhance the usefulness of the model by expanding the potential audience for its output.



APPENDIX B

PROJECTED BALANCE SHEET

To promote the ease of understanding the SAMICS output for financial people and government policy analysts, a projected financial balance sheet should be produced as part of the output. A projected balance sheet for the model industry would summarize the assets and liabilities as of a given date (the design manufacturing year) in accordance with generally accepted accounting principles. Since this statement is a familiar means of communication in the business world, it would facilitate analysis by potential investors and policy makers. It would also supply standardized data to compute the various financial ratios commonly used to evaluate and compare alternative investments.

A sample balance sheet is shown in Exhibit B1. The assets and liabilities of SAMCO, the hypothetical enterprise, are classified according to standardized accounting procedures. The assets are divided into three primary categories:

- Current assets
- Fixed assets
- Intangible assets

Similarly, liabilities are classified as:

- Current liabilities
- Fixed liabilities
- Stockholders' equity

Current assets such as cash and inventories are recorded at actual value. Receivables are also taken at face value but may be reduced by an allowance for bad debts.

EXHIBIT B1

SAMCO CORPORATION

PROJECTED BALANCE SHEET
FOR SEPTEMBER 30, 1986

ASSETS:

Current Assets

Cash
Marketable Securities
Accounts Receivable
Inventories
 Raw Materials
 Work in Process
 Finished Goods
 Total Inventory

Other Current Assets

Total Current Assets

Property, Plant and Equipment (At Cost)

Land
Buildings, and Improvements
Machinery and Equipment
Less Accumulated Depreciation
Property Plant and Equipment (Net)

Investments and Other Assets

Total Assets

LIABILITIES AND STOCKHOLDERS' EQUITY

Current Liabilities

Bank Loans
Other Notes Payable
Accounts Payable
Accrued Wages
Accrued Expenses
Accrued Income Taxes

Total Current Liabilities

Stockholders' Equity

Common Shares
Paid-In Capital
Retained Earnings

Total Stockholders' Equity

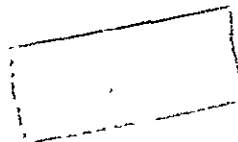
Total Liabilities and Equity

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Work-in-process and finished goods inventory values are composed of material labor, overhead, and depreciation cost estimates.

Fixed assets such as land are usually valued at the minimum of purchase price or market value while buildings and machines should be listed at cost plus improvements, less accumulated depreciation. Because of inflationary and possibly deflationary effects, the balance sheet value of fixed assets is usually substantially different than the actual market value.

Intangible assets, by definition, cannot be valued physically, so the values listed must be estimated carefully using experienced accounting judgment.



APPENDIX C
FINANCIAL RATIO ANALYSIS

Financial analysts have developed several standard measures to evaluate investment opportunities. The appropriate measures vary with the type of application. In the case of SAMICS, financial analysts would be interested in the capital structure of the firm, projections of future profitability and the cash flow ability of the firm to service debt over the long run.

To accomplish this, several standard financial ratios could be computed from the projected SAMICS financial statements: the balance sheet and the income statement. The analysis of these financial ratios involves making comparisons for alternative manufacturing processes and for similar industries.

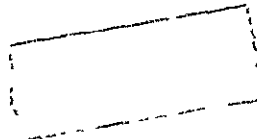
Financial ratios can be divided into four types:

- Liquidity
- Debt
- Profitability
- Coverage

Each has a special use and is employed extensively by creditors and investors. A comparison of ratios of firm over-time can provide valuable insight to evaluate changes and trends in the firm's financial condition and profitability. Ratios may also be evaluated in comparison with those firms in the same line of business or with industry averages. It is important to recognize that no single ratio should be used to judge a firm, rather, a group of ratios should be used. Analysis and interpretation of these financial ratios will give a skilled and experienced



financial analyst a better understanding of the potential financial condition and performance of the solar energy firm than he would obtain from the analysis of the financial statements alone.



I. LIQUIDITY RATIOS

$$\text{CURRENT RATIO} = \frac{\text{CURRENT ASSETS}}{\text{CURRENT LIABILITIES}}$$

$$\text{ACID-TEST RATIO} = \frac{\text{CURRENT ASSETS} - \text{INVENTORIES}}{\text{CURRENT LIABILITIES}}$$

$$\text{AVERAGE COLLECTION PERIOD RATIO} = \frac{\text{RECEIVABLES} * \text{DAYS/YEAR}}{\text{ANNUAL CREDIT SALES}}$$

$$\text{INVENTORY TURNOVER RATIO} = \frac{\text{COST OF GOODS SOLD}}{\text{AVERAGE INVENTORY}}$$

II. DEBIT RATIOS

$$\text{DEBT-TO-NET WORTH RATIO} = \frac{\text{TOTAL DEBT}}{\text{NET WORTH}}$$

$$\text{LONG TERM DEBT TO CAPITAL RATIO} = \frac{\text{LONG-TERM DEBT}}{\text{TOTAL CAPITALIZATION}}$$

III. COVERAGE RATIOS

$$\text{INTEREST COVERAGE RATIO} = \frac{\text{EARNINGS BEFORE INTEREST AND TAX}}{\text{INTEREST CHARGES}}$$

$$\text{CASH FLOW COVERAGE RATIO} = \frac{\text{ANNUAL CASH FLOW BEFORE INTEREST \& TAXES}}{\text{INTEREST} + (\text{PRINCIPAL PAYMENTS}) / (1 - \text{TAX RATE})}$$

IV. PROFITABILITY RATIOS

$$\text{GROSS PROFIT MARGIN} = \frac{\text{SALES} - \text{COST OF GOODS SOLD}}{\text{SALES}}$$

$$\text{NET PROFIT MARGIN} = \frac{\text{NET PROFIT AFTER TAXES}}{\text{SALES}}$$

$$\text{RETURN ON EQUITY} = \frac{\text{NET PROFIT AFTER TAX} - \text{PREFERRED STOCK DIVIDEND}}{\text{NET WORTH} - \text{PAR VALUE PREFERRED STOCK}}$$

$$\text{RETURN ON ASSETS} = \frac{\text{NET PROFIT AFTER TAX}}{\text{TOTAL TANGIBLE ASSETS}}$$

$$\text{NET OPERATING PROFIT RATE ON RETURN} = \frac{\text{EARNINGS BEFORE TAX \& INTEREST}}{\text{TOTAL TANGIBLE ASSETS}}$$

$$\text{TURNOVER RATIO} = \frac{\text{SALES}}{\text{TOTAL TANGIBLE ASSETS}}$$

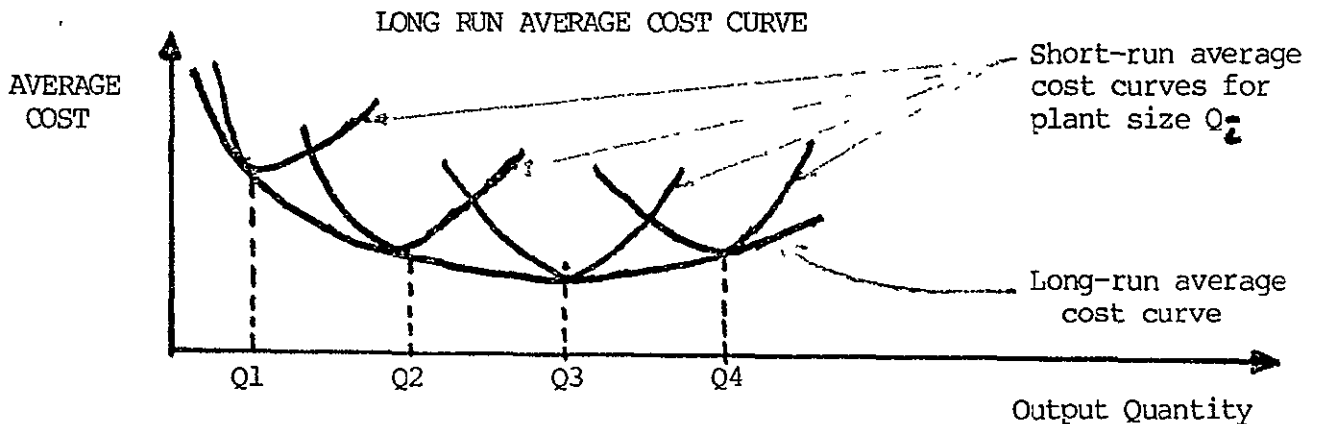
APPENDIX D

LONG-RUN AVERAGE COST ASSUMPTION

The SAMICS steady state cost calculations assume that all costs including capacity expansion are completely variable. Whereas short-run costs are predicated on a given set of facilities, production techniques, etc. that cannot be changed over a short period of time, long-run cost estimates are based on a time period sufficiently long so that all factors affecting costs and output may be considered completely variable.

LONG-RUN AVERAGE COST CURVE

A long-run cost function represents the relationship between facility size measured by the quantity produced and the cost of production. This function can be described theoretically as the envelope of an infinite number of short-run cost curves as illustrated below:

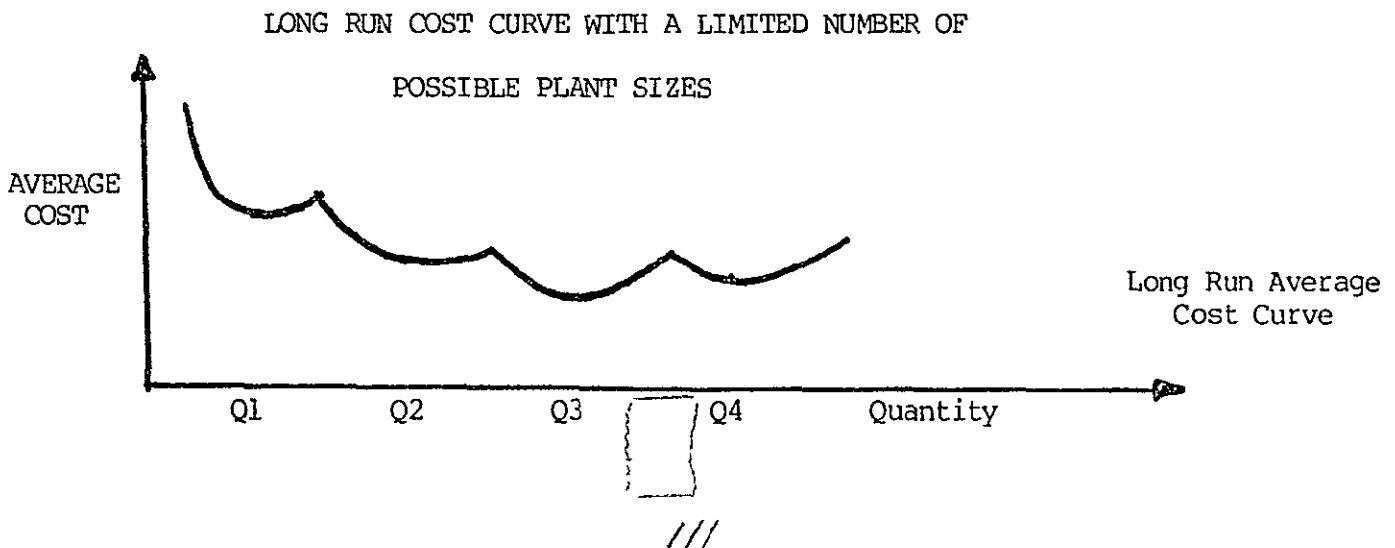


Each point on the long-run average cost curve represents a different size facility. The short run cost curves are established for a given plant size assuming a constant technology, input prices, labor rates, etc. The long run

average cost curve represents the average cost associated with a given level of output assuming that the optimum plant size for producing that output has been chosen. The basis for this assumption is that the output quantity desired is known, then it is possible to design and construct a facility that will minimize the cost of producing that output. The average long-run cost for each output quantity is the average cost incurred using the optimal plant size for that volume.

Each size of facility can operate at other output levels by adjusting the amount of labor and other inputs. As the output quantity desired increases, larger capital investments are required to obtain lower short-run average costs. Depending upon the state of technology and the input costs at a given time, there is an optimum plant size which will yield the lowest short-run average cost curve. This plant size is Q on the previous diagram.

This theoretical exposition assumes that the size of facilities is continuous. However, in the real world, only a finite number of plant sizes are possible. In this case the long-run average cost curve actually follows or is made up of the short-run average cost curves for each of these possible plant sizes as shown below.



This curve can be approximated by the output of the SAMIC model for each of the alternative manufacturing processes for producing photovoltaic solar arrays. One of these processes may prove superior over all ranges of output. However, more probably the optimal process will vary with the facility size. In this case, an estimate or probability distribution for the demand will indicate which process should be selected to minimize the long-run average cost.

OPTIMAL SCALE OF OPERATION

In designing a facility which is expected to operate at a given level of output, the size should be chosen so that its short-run cost curve is tangent to the long-run curve at the given level of output. As shown previously, this point of tangency lies to the left (right) of the short-run minimum cost point for levels of output lower (higher) than the long-run minimum cost point. For the optimum sized facility, the point of tangency coincides with both the short-run and the long-run minimum cost points. This implies that for outputs below the long-run minimum cost level, it is more economical to under-utilize a slightly larger facility than to operate a smaller facility at its minimum cost level. Conversely, for outputs greater than the long-run minimum cost point, it is more economical to over-utilize a slightly smaller facility than to operate a larger facility at its minimum cost level. Only when the facility is designed to produce the long-run optimum output (optimum for the current state of technology) will it be most economical to operate at the short-run minimum cost point.

Long-run cost functions can be a valuable management tool for long range strategic plans for plant size as well as for the development of operational



performance standards. Long-run average cost curves are useful to management in planning capital expenditures and capacity expansion. However, it is also important to consider the short-run cost variations in determining the optimal facility size. Analysis of this variation will indicate how costs change when the plant is not operated at its design level. To improve the control of costs and the investment risk in a multi-firm industry, it is necessary to know the magnitudes of possible short-term cost variations associated with different facility sizes. As mentioned previously, the SAMICS model output will approximate the long-run average cost curve, but the output does not currently include the short-run cost variation. However, the model contains provisions for determining the short run variations quite easily.

To accomplish this, the machine process usage fractions and the number of shifts per day could be varied for each level of industry scale. The level of industry scale is established by the number of machines and the facility size. The operating costs resulting from each of these variations would approximate the short run average cost curves associated with different facility sizes. From this information, decisions regarding the optimal scale of operation could be made more prudently.

The long-run cost curve indicates the relative economy of different facility sizes or levels of operation at a given time under a fixed set of technological and economic conditions. With new developments in manufacturing processes, equipment design or operating methods and with changes in input prices and wage rates, long-run costs will change and new standards must be developed.

INDUSTRY STRUCTURE

To manufacture a given product, the size of the facility may vary for one or more of the following three reasons:

1. Vertical Integration: A firm manufacturing its own parts has more depth than one that assembles purchased parts.
2. Horizontal Integration: A plant operating its own marketing distribution and warehouse organization has more width than one that markets through selling agents.
3. Output Income: Greater volumes of output require larger production facilities.

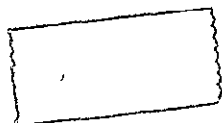
In the SAMICS long-run cost analysis, the manner in which facilities vary with output volumes is of primary interest. Thus, it is critical that the industry structure be carefully defined with respect to the extent of horizontal and vertical integration for the long-run cost variations we are measuring.

The difference between facility size and the size of the firm should also be recognized. Because of the number of individual plants or facilities included in its organization, a firm with separate albeit smaller manufacturing and assembly plants, spread out over the country, may be large in total output capacity and more cost effective than a firm with a single large plant. This is, while a firm may be vertically integrated, its plants may not be vertically integrated.

Futhermore, warehousing and distribution functions, which are outside of the current scope of the model, may lead to decreasing returns or diseconomies

of scale after a point due to increasing transportation costs. Thus the SAMICS assumptions regarding industry structure are important. The extent of horizontal and vertical integration need to be specified explicitly since these concepts will have significant consequences for the model results.

The SAMICS model is capable of assessing the impact of vertical integration easily but, with a little more data preparation, the effect of horizontal integration could be examined.



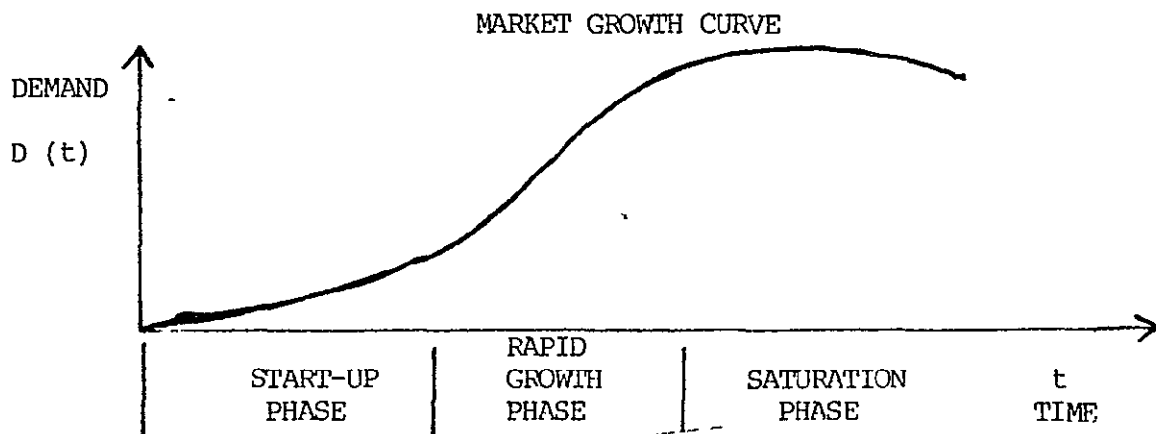
APPENDIX E
CAPACITY EXPANSION POLICY CONSIDERATIONS

INDUSTRY GROWTH

In a flow-shop manufacturing firm such as the solar array manufacturing industry, the initial design capacity decision involves a major capital investment for plant and equipment. Similarly, capacity expansion will involve the retirement and replacement or the addition of major pieces of equipment and facilities at a substantial capital investment.

In this context, the determination of the optimal size and scale of facilities is very important. The dominant variable in this decision is the expected demand for the firm's product translated into capacity requirements over time. The SAMICS model treats the demand statically, varying over a specified range. However, demand is seldom static and the long-term growth pattern is especially important for a new product.

In the SAMICS model, the plant design capacity is based on a constant steady state production rate over the life of the facilities. The demand for solar arrays, however, can be expected to follow a growth pattern exhibited by the classical S-curve over time:

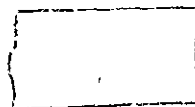


The growth pattern starts with a relatively short period of slow steady growth lasting between two and five years. This is followed by a major growth period where the demand increases rapidly at an exponential rate. The rapid growth period could vary between five and 20 years, depending on many factors such as the market price, customer acceptance, price of substitutes, and the rate of substitution. The saturation phase begins as new technology is developed and the product becomes vulnerable to substitution of other new products.

The leveling off period is likely to be followed by a period of decline. This growth pattern raises two major questions regarding plant capacity. The first is: given the anticipated growth in product demand, how much plant capacity should be installed initially? Second, what is the optimal size and timing of future capacity expansions? The answers to these questions have important consequences on the economic attractiveness of the investment.

Several capacity expansion policies could meet the demand function described above. At one extreme, sufficient capacity could be installed initially to supply the maximum expected demand. At the other extreme, capacity could be expanded in small increments as demand increases. Obviously there are many alternatives within this range. These factors force the issue of planning for the size and timing of capacity expansion. This investment decision is complicated further by uncertainties in the demand forecasts, cost estimates, and the process performance.

The economics of this decision involve several tradeoffs. Constructing excess capacity offers economies of scale in planning, construction, and initial start-up capital costs. It also reduces inflationary effects. On the other hand,



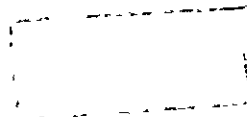
incremental expansion avoids tying up capital in unutilized capacity. Furthermore, it guards against obsolescence due to new technological developments and errors in long-term forecasts. The fundamental issue is the size and timing of present and future demand estimates and the corresponding cash flow requirements. Ultimately, the initial plant design should include the selection of the production process, plant size and location, and a plan for expansion, as well as the anticipated timing of the cash flows.

These considerations are currently beyond the scope of the SAMICS model, which is restricted to the supply side of the market. However, at some point in the future, the model should be expanded to analyze the interaction of supply and demand. Such a dynamic model would provide the capability of examining the implications of industry growth and alternative capacity expansion policies on the eventual price of solar arrays and the attractiveness of the investment.

UNCERTAINTY IN PROCESS CAPACITY

When a production process is in the design stages, the expected rate of production for a given design level is really uncertain and will not be known until the process has been operating for some period of time. In the case of the SAMICS model industry, the plant to be designed could be composed of several processing facilities in series so that the uncertainty associated with each facility's expected output rate requires a safety factor in the plant design to ensure a specified expected industry output rate.

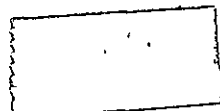
For example, consider a plant that is being designed with N processes in series; obviously the plant output rate will be constrained by the minimum rate of any operation in the series. This situation can be optimized by various techniques commonly known as production line balancing.



Suppose that each operation is being designed for an expected output rate of Q_j peak-watts/year. However, the actual average output rate is a random variable. Assume that it is normally distributed with mean \bar{Q}_j and standard deviation σ_j . Then the actual average output rate of the industry will also be a random variable approximately a normal distribution with mean \bar{Q} and standard deviation σ .

Suppose that an industry output rate Q is desired, then the uncertainty of both the operation rate and the number of operations in series affects the probability of meeting the desired rate. The determination of expected capacity assuming a static demand rate requires a decision regarding what risk should be taken of the plant not meeting the desired rate. Traditionally, this has been handled by incorporating a safety factor in the design that will assure attainment of the desired capacity. Optimizing this factor involves a tradeoff between increased capital costs for the extra capacity versus the costs of insufficient capacity such as lost sales.

The SAMICS model is capable of analyzing the uncertainty in process capacity by varying the process usage functions. However, at this point, it would be more practical to simplify the matter by treating process capacity deterministically.



APPENDIX F

LEARNING CURVE MODEL FOR PRODUCTION STARTUP

When a factory is constructed to produce a new product using new processes, it is generally understood and intuitively logical that there will be a reduction in the resources spent per unit of output as the cumulative number of units produced increases. In other words, the production rate can be expected to increase during the startup period until the design capacity is reached. This improvement over time, commonly referred to as the production learning function, occurs as a result of debugging and fine-tuning the manufacturing organization. That is, methods are changed, tools are redesigned, facilities are reorganized, paperwork moves faster, and everyone learns to perform their tasks more efficiently.

The SAMICS model currently assumes that the plant construction phase is followed by a production startup period. During this period costs are incurred and resources are consumed, however, the production rate is assumed to be zero until the steady state is reached when the output level is equal to the design capacity. This assumption ignores the revenue cash flows generated by the initial output which will offset the startup costs and thus lower the initial working capital requirements.

Thus, the effect of this assumption is a higher price since these startup costs are amortized over the life of the facilities and included in the eventual price estimate.

The model could easily be expanded to include a production learning function illustrated in Exhibit F1. This function can be expressed quantitatively

as follows:

$$Q(t) = \begin{cases} Q_0 t^\alpha & \text{for } 1 \leq t < t_c \\ Q_c & \text{for } t \geq t_c \\ 0 & \text{otherwise} \end{cases}$$

Where $Q(t)$ = output rate at time t
 Q_0 = initial output rate
 Q_c = capacity or design output
 t_c = startup time required to reach capacity
 α = manufacturing progress rate

Given the design capacity, Q_c , and the length of the startup period, t_c , which are currently used in the SAMICS model, the progress rate, α , can be computed from an estimate of the starting production rate, Q_0 :

$$\alpha = \frac{\log Q_c - \log Q_0}{\log t_c}$$

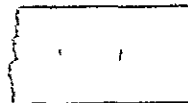
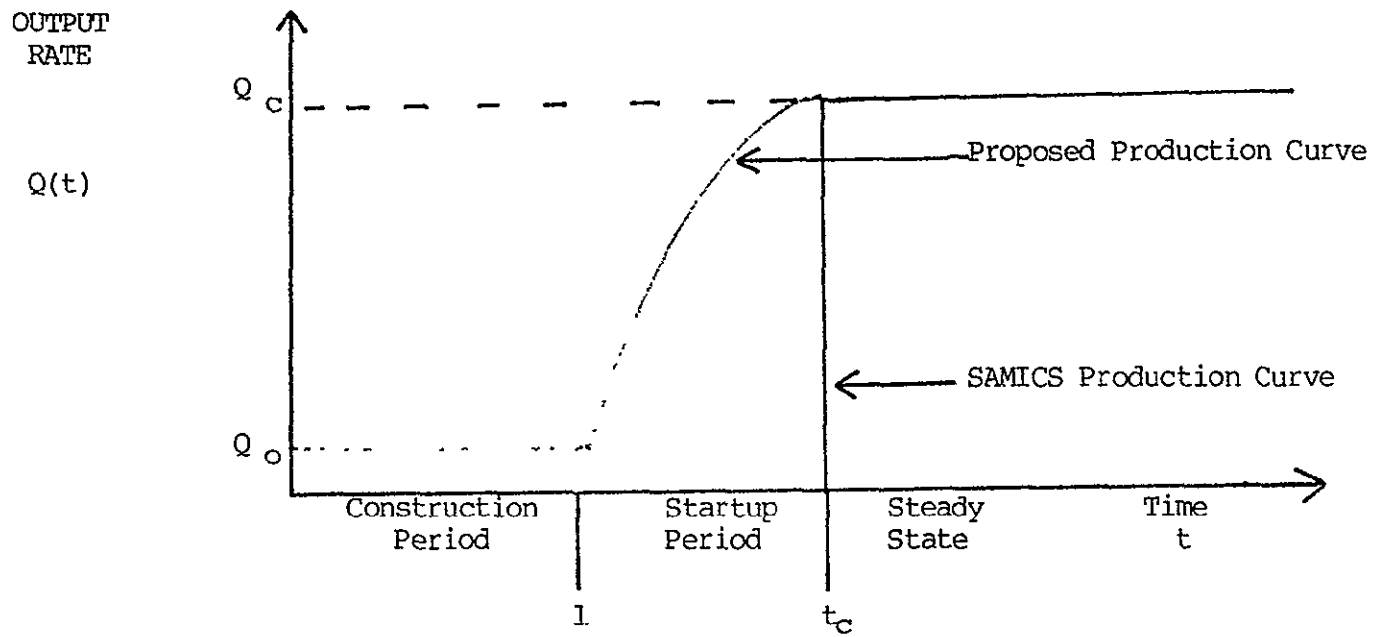


EXHIBIT F1

STARTUP PRODUCTION LEARNING CURVE



APPENDIX G

INVESTMENT TAX CREDIT MODEL

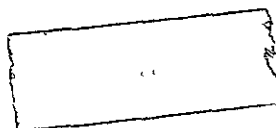
This appendix contains a brief description of the most recent IRS rules and regulations governing Investment Tax Credits. This descriptive information formed the basis for the analyses and recommendations presented in the Theoretical Model Validity section. An Investment Tax Credit model is proposed to incorporate this information in the SAMICS methodology.

• Credit Rate

As a result of the Tax Reform Act of 1976, the Federal Income Tax Credit Rate for investment in depreciable personal property was raised from 7% to 10% and extended through 1980. This implies that a credit is allowed in general for 10% of the qualified investment property acquired or constructed during the period beginning January 22, 1975 and ending December 31, 1980. An additional 1% may be claimed if an equivalent amount is contributed to an employee stock ownership plan. Similarly, another .5% is permitted if employee contributions equal the .5%.

• Carry-back and Carry-forward

The credit is normally allowed for the year the qualifying property is placed in service. However, any part of an allowable tax credit, which is unused due to limitations described below, may be carried back three years and carried forward seven years. Similarly, an unused investment credit arising from a net operating loss can be carried back three years and forward seven years.



• Investment Credit Limitations

The investment credit claimed may not exceed the tax liability. The liability to which the credit rate may be applied is the income tax minus foreign tax credits and credit for the elderly. However, the Investment Tax Credit may not exceed 50% of the tax liability.

• Qualified Investments

With certain exceptions, qualified investments consist of depreciable property having a useful life greater than or equal to three years. This includes:

- 1) Tangible personal property
- 2) Other tangible property (not including a building or its components) used as an integral part of
 - a) manufacturing
 - b) extraction
 - c) production
 - d) furnishing of transportation, communications, electrical energy, gas, water, or sewage disposal services
- 3) Elevators and escalators
- 4) Research facilities and facilities for the bulk storage of fungicidal commodities (including liquids or gases) with the activities in 2a-2d

The Investment Tax Credit is not allowed for rehabilitation expenditures for the cost of certain pollution control and on-the-job training facilities, if a rapid depreciation method is elected. Property used by a tax-exempt organization or property leased by or to a government agency may not be claimed for investment credit.

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• Tax-Life Restrictions

The credit is allowed only for the year in which the qualified property is placed in service. The amount of credit is computed as the sum of the cost of new qualified investments and up to \$100,000 of the cost of used property.

The qualifying cost is limited, if the property has a tax-life less than seven years. The limitations are listed below:

- 1) No credit is allowed if the tax-life is less than three years.
- 2) One-third of the credit may be claimed if the tax-life is greater than or equal to three years and less than five years.
- 3) Two-thirds of the credit may be claimed if the tax-life is greater than or equal to five years and less than seven years.
- 4) Full credit is allowed if the tax-life is seven or more years.

o Recommended Model

The allowable credit rate is a function of the maximum credit rate, α , and the tax-life, TL, of the investment.

$$\text{ITC (TL) = Allowable credit rate function} = \begin{cases} 0 & \text{for TL} < \text{TL.BOT} \\ 1/3\alpha & \text{for TL.BOT} \leq \text{TL} < \text{TL.MID} \\ 2/3\alpha & \text{for TL.MID} \leq \text{TL} < \text{TL.TOP} \\ \alpha & \text{for TL} \geq \text{TL.TOP} \end{cases}$$

The standard values for these Investment Tax Credit parameters should be:

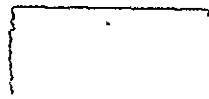
$$\alpha = 11\%$$

$$\text{TL.BOT} = 3 \text{ years}$$

$$\text{TL.MID} = 5 \text{ years}$$

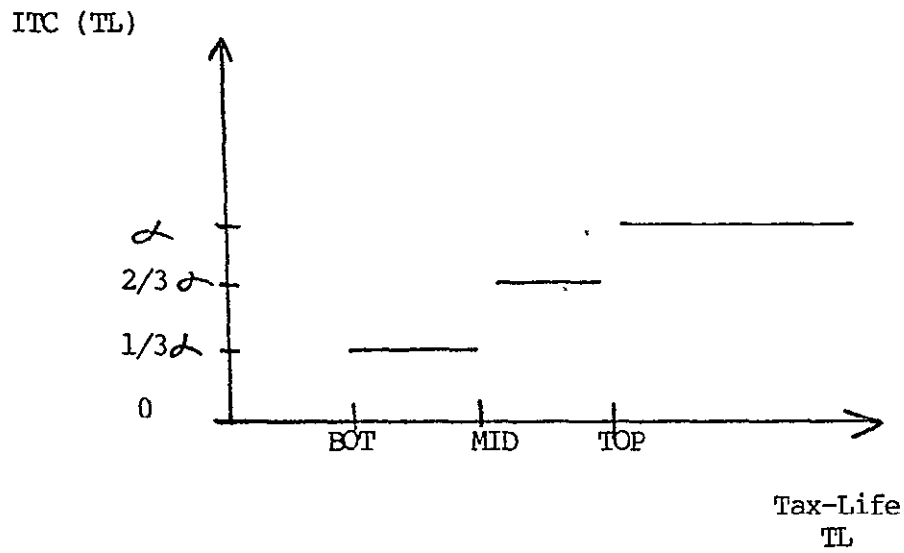
$$\text{TL.TOP} = 7 \text{ years}$$

The maximum credit rate should be 11% assuming 1% is contributed to an employee stock ownership plan.



ALLOWABLE INVESTMENT TAX

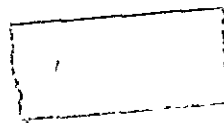
CREDIT RATE FUNTION



In addition, the maximum credit should be restricted as follows:

$$\text{MAX.ITC} = \text{T} / 2$$

Where TAX = Federal Income Tax Liability



APPENDIX H

JOB TAX CREDIT MODEL

This appendix contains a brief description of the new Job Tax Credit proposed in the Tax Reduction and Simplification Act of 1977. This credit will have important tax consequences for all employers, especially those which will hire a large amount of new unskilled labor. New and rapidly expanding companies will be limited; however, the unused credit may be spread out over several years.

● New Credit

The Tax Reduction and Simplification Act of 1977 provides a new Jobs Tax Credit. The maximum credit for each net new employee hired by an employer is \$2,100 which is 50% of the first \$4,200 of wages paid to net new employees. The corporate income tax deduction for the expense of wages must be reduced by the amount of credit claimed. More than one-half of the wages paid must be for services performed in the United States, in a trade or business of the employer, if remuneration paid to any one employee is to qualify for the credit.

The credit is generally based on FUTA (Federal Unemployment Tax Act Wages) paid by an employer during the year in excess of 105% of FUTA wages paid during the preceeding year. This limit is computed by subtracting 105% of the last year's wages from this year's wages.

The maximum credit allowable for an employer is \$100,000 per year.

- Bonus Credit

The act also provides an additional 10% tax credit for all new employees that are handicapped and have received vocational rehabilitation (including handicapped veterans). This special 10% credit is limited to one-fifth of the 50% credit that would have been allowed before applying the \$100,000 limitation.

- New Business

To limit the credit available to a new or rapidly expanding business, wages on which the credit is based are limited to 50% of FUTA wages for the year. However, it should be noted that the 105% total wage limitation is applied independently of the rule for new and rapidly expanding businesses. For example, the Tax Conference Committee Report indicates that even though the new business rule limits the amount taken into account as an increase in FUTA wages for the year, the new business rule will not limit the amount taken into account as an increase in total wages paid during the year.

- Limitations Based on Amount of Tax

The amount of the Jobs Tax Credit allowed for the taxable year may not exceed the amount of Federal Income Tax Liability reduced by the foreign tax credit, the tax credit for the elderly, the investment tax credit, and the political contributions credit.

- Carryback and Carryforward

If the allowable credit exceeds the limitations outlined above, the unused credit may be carried back to each of three taxable years preceeding the

unused credit year, and carried over to each of the seven taxable years following the unused credit year.

The amount of the unused credit that may be carried back or carried forward may not exceed the amount by which the limitation exceeds the sum of the credit allowable for such a taxable year.

